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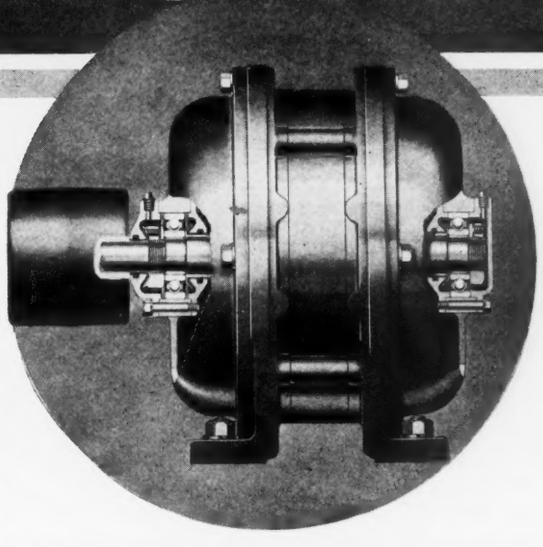
Ball-bearing Electric Motors



Advantages of Ball Bearings for Motors and Methods of Mounting and Lubricating

By T. C. DELAVAL-CROW, Chief Engineer,
The New Departure Mfg. Co., Bristol, Conn.

AT recent meetings held by the Association of Iron and Steel Electrical Engineers, papers were read by ball bearing manufacturers regarding the application of ball bearings to electric motors. During the discussion, many opinions were expressed by electrical superintendents about the use of ball bearings. The opinion of the user is based on actual facts —not engineering theory—and is, therefore, really the deciding factor as to whether this type of motor should be adopted. If these opinions are true (see quotations at bottom of this page), they certainly justify the claims that ball bearings lengthen the motor life and reduce the upkeep expense.

Users of ball bearings on general-service motors should thank the Association of Iron and Steel Electrical Engineers, because of the fact that all the ball bearing manufacturers now recommend the same size bearing for motors of given horsepower rating, speed, and general structure; therefore, no matter what make of bearing is used, all bearings are strictly interchangeable, and are guaranteed by all the ball bearing manufacturers.

The power saving due to the fact that the ball bearing is 99 per cent (Kimball and Barr's "Elements of Machine Design") efficient is not so important as the fact that wear is reduced. Actually, in a ball bearing the wear is so small that even after millions of revolutions, or years of service, it cannot be measured. Furthermore, in a ball bearing, the starting and running friction is practically the same. According to Professor Goodman, the ratio of ball-bearing starting effort to running frictional resistance for loads from 1000 to 6000 pounds is 1.6 to 1.0, whereas for a good white metal bearing, based on the same loads, the ratio is 5 to 1.5. Apart from the fact that the coefficient of sliding friction is 0.7, and that of rolling friction 0.0017, the increase in starting resistance with increase in load is due to the fact that a plain bearing depends on an oil film for reduction of friction, and this film, even under ordinary loads, is destroyed while the bearing is at rest. On the other hand, in a ball bearing, efficiency is not dependent on the lubricant; hence both starting and running resistance are low.

Some of the opinions concerning the advantages of ball-bearing electric motors, as expressed at recent meetings of the Association of Iron and Steel Electrical Engineers were as follows:

"Use of ball bearings will allow a reduction of motor maintenance force of 60 per cent."

"Average life of plain bearings on a motor subject to shock load, three weeks; life of ball bearings on a motor in same service, three years."

"Ball bearings on a crane bridge motor gave five times the life of plain bearings."

"In electrical coal mine locomotives, life of plain bearing motor, fifteen weeks; that of ball-bearing motor, twenty-three months."

The greatest recommendation for a ball-bearing electric motor is the simplification of lubrication, and as wear does not occur, the bearing can be permanently enclosed, so that the lubricant is retained and the entrance of foreign matter—such as dust, grit, or moisture—excluded from the bearing. As the efficiency is not dependent on the film of oil to keep the bearing surfaces apart, the amount of lubricant in the housing is not so vital a matter as in the case of a plain bearing. Actually, the ball bearing operates on a metal-to-metal contact, and the pressure at the contact areas runs as high as 130,000 pounds per square inch, which absolutely prohibits any oil film from being present at these areas. Under normal operating speeds up to about 4000 revolutions per minute, grease can be successfully used for lubrication instead of oil, and if a proper enclosure is used, it is only necessary to lubricate once in six months or even longer periods. Another point of interest is that if grease is used for a lubricant, the motor can be shipped ready for operation, which is not so in the case of a plain bearing, as the Interstate Commerce Commission absolutely prohibits shipment of machinery in which oil reservoirs are full of oil. This ruling, however, does not apply to grease.

Nature of Load on Motor Bearings

Stock electric motors are often sold and guaranteed without the manufacturer knowing the exact nature of the drive and the resultant load imposed on the bearings. For instance, the motor might be direct-coupled, which subjects the bearings and shafts to torsion only, and the function of the bearing is to support the weight of the rotor. On the other hand, the motor may have to withstand severe shocks, as in driving crushers, or may drive through very low grade of gearing.

After studying the loads imposed by various types of drives, it is found that the belt drive creates the greatest load. As a rule, sufficient initial tension is applied to the belt to insure that slip will not occur at the maximum overload, and this initial tension is usually much greater than that theoretically required to transmit the normal full load, so that, actually, the load on the bearing will

be practically the same at all outputs of the machine, as it depends primarily on the initial belt tension. In gear drives, however, the load varies directly with the output of the machine, and with a motor operating at varying loads, the bearing is not always working under maximum load; hence even after considering the allowance that must be made for inaccurate machining, a bearing should last considerably longer under a gear drive than in the case of a belt. Chain drive produces practically the same load as that obtained by gears, and therefore requires no further consideration.

In the case of direct coupling, the bearings are not subjected to external loads as with the drives mentioned, though particular attention should be paid to the alignment, for if this is not done, considerable loads may be imposed on the bearings due to the crank action set up by coupling together two misaligned shafts.

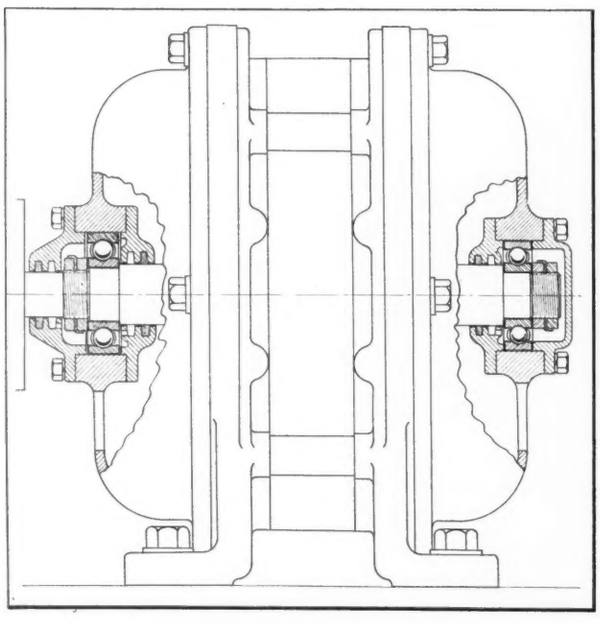


Fig. 1. Motor with Ball Bearing Mounting having Inner and Outer Closure Caps

Life of Ball Bearings Under Given Load

The next question that often arises is how long will the ball bearing last under a given load? As a general statement, it is safe to say that standard ball bearing practice today is to allow a factor of 2.25 to 3 when the listed capacity of the bearing at operating speed is divided by the maximum imposed load. Laboratory tests on bearings run under various overload conditions, indicate that with the factor mentioned, a life of 31,600 hours would be obtained. This is equal to approximately ten years of service at ten hours per day; however, as this life is based on tests run under extremely heavy overload, it is reasonable to believe that under the much lighter load conditions, this life will be exceeded if the bearing is correctly housed and lubricated.

At this point, it is well to note that the operating temperature of the bearing is a factor that may affect the life obtained. Electric motors operate under a guaranteed temperature rise of not over 40 degrees C., above the room temperature. It should be remembered that this is the temperature of the windings, and due to radiation, the temperature of the bearings themselves will be considerably lower; this temperature will rarely be above 50 degrees C. Tests have shown that between the range of 15 to 55 degrees C., there is no appreciable change in the load-carrying capacity of the bearing, and the rise in motor operating temperature, therefore, is not detrimental, but if the temperature is much higher or lower than the limits mentioned, the bearing selection factor obtained by dividing the capacity by the imposed load will have to be increased.

Methods of Mounting Ball Bearings

Ball bearings can be mounted in several ways, each of which has its advantages and disadvantages. The first is that in which the bell housing of the motor is bored straight through, and two closure caps are used for each housing, as in Fig. 1.

Advantages—Bearing seat machined straight through; easy to assemble bearings on shaft; bearings can be assembled on shaft before inserting end bell; end bells readily removed; bearing readily removed; visual inspection of bearings without removing end bell.

Disadvantages—Hard to assemble bearing cap bolts on a fully enclosed motor; bearing exposed to dirt on removing end bells; four joints between cap and housing to be sealed against leakage.

The next mounting to be considered is one in which the inner cap is cast solid with the bell housing, as in Fig. 2.

Advantages—Least number of parts; easy to assemble bearing caps; visual inspection of bearings without removing end bell.

Disadvantages—Blind bearing seat to machine; bearings have to be assembled on shaft after end bells are in place; bearing has to be pulled from shaft to remove end bells; hard to disassemble bearing from shaft.

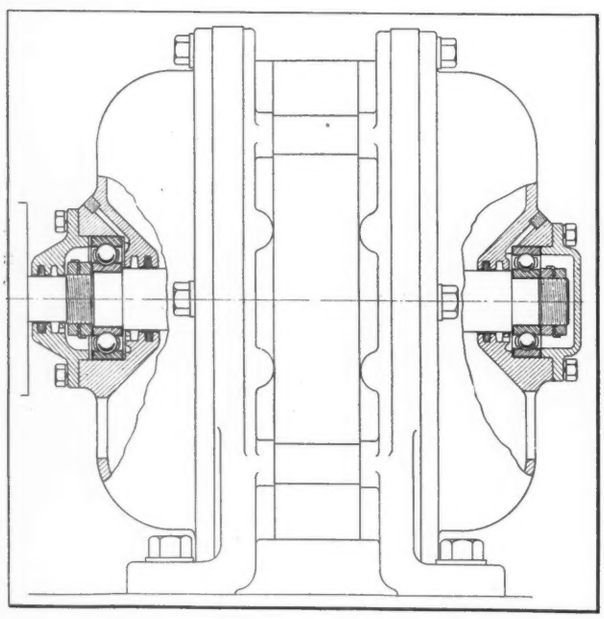


Fig. 2. Mounting having Inner Closure cast Integral with Bell Housing

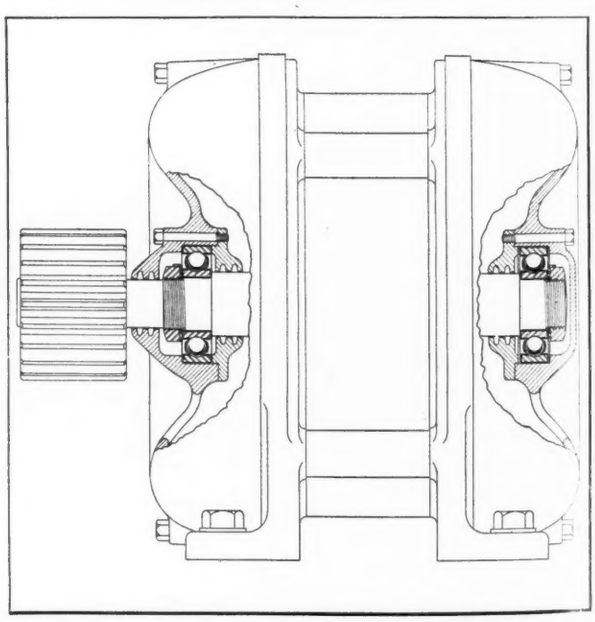


Fig. 3. Mounting in which Outer Cap is Integral with End Shield

Another method of assembly is shown in Fig. 3. The outer cap in this instance is integral with the end shield.

Advantages—Least number of parts; easy to assemble bearings on shaft; bearings can be assembled on shaft before inserting in end bell; end bells readily removed; bearings readily removed.

Disadvantages—Blind bearing seat to machine; hard to assemble bearing cap bolts on fully enclosed motor; bearings exposed to dirt on removing end bells; visual inspection of bearing requires removal of end bell.

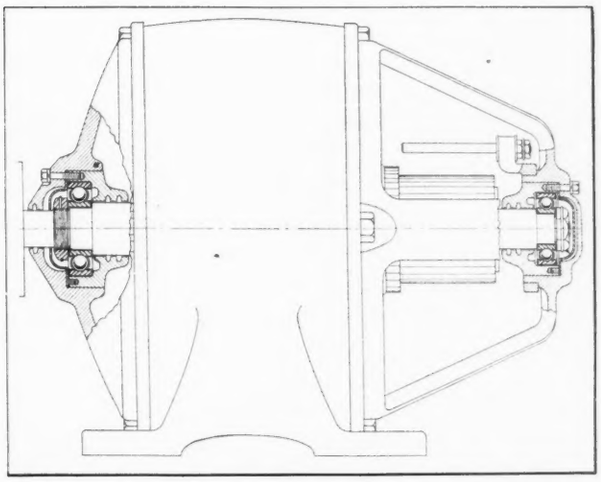


Fig. 4. Spool Mounting adapted to Motors requiring Armature Removal for making Commutator Repairs

The spool mounting, as shown in Fig. 4, is not necessary in the case of designs that do not require commutators, but should be very carefully considered for motors in which commutator repair requires removal of the armature from time to time, in which case it is advantageous to have the bearing completely enclosed.

Advantages—Bearing enclosed at all times; can be handled as a unit with the armature; spool readily machined, as it is a relatively small part; easy to assemble bearing on shaft; spare unit can be carried with enclosed bearing and completely assembled for replacement in case of armature breakdown.

Disadvantages—Increased cost due to one extra hole to be bored and extra machining on outside diameter of spool; blind bearing seat to machine; hard to disassemble bearing from shaft; visual inspection of bearing requires removal of end bell.

Mountings for High Speeds

With the use of the high-frequency induction motor, speeds between 12,000 and 24,000 revolutions per minute are often obtained. The bearing mounting, in this case, should be of the angular contact type, and very careful attention should be paid to the means of supplying lubricant, as it is necessary at these high speeds to be sure that the lubricant is supplied to the rubbing surfaces between the ball and the separator where there is pure sliding friction, or else failure will occur in a very short time. The common practice of feeding oil directly on the spindle is wrong, since centrifugal force prevents the lubricant from reaching the bearing.

The standard high-speed mounting is two angular contact bearings mounted opposed at one end, and a single angular contact with spring adjustment at the other end, as shown in Fig. 5. At the double bearing end, the oil is fed directly between the bearings and cannot escape. At the other end, oil is fed to the open side of the bearing, a steel washer being used, of such a form that the oil is fed directly to the bearing.

Mountings for Vertical Motors and Oiling System

In the case of the vertical motor, there has been no standardization up to this time as to the bearing size, although, no doubt, this will be effected when the motor design itself has been made more uniform. The mounting, however, is relatively simple, an angular contact bearing being used at one end to sustain the rotor weight and whatever exterior load the motor is guaranteed to carry. This exterior load is that obtained when the bearing capacity at rated speed is divided by two to three and the rotor weight subtracted. The lower end is supported by a straight annular bearing which really carries no load beyond that of shaft misalignment. The mounting requires a little more consideration and careful study than is the case with the horizontal motor, because gravity is working continuously to cause lubricant leakage. However, this is readily overcome by using the quill type mounting shown in Fig. 6, in which the quill forms a dam whose wall is higher than the lubricant level and so prevents leakage.

Particular attention is called to the sleeve that carries the bearings. It will be noted that this is threaded on the end farthest from the armature, this thread having the dual purpose of securely clamping the inner race and allowing a threaded puller to be inserted in place of the lock-nut, thus permitting the sleeve and bearing to be removed without disturbing the end bells or exerting pressure on the outer race of the bearing itself.

In the high-speed vertical motor, the lubrication problem presents serious difficulty, and, as in the case of the horizontal motor, too much oil is as detrimental as too little. The only really satisfactory solution is a circulating oil system, such as is depicted in Fig. 8. It will be noted that

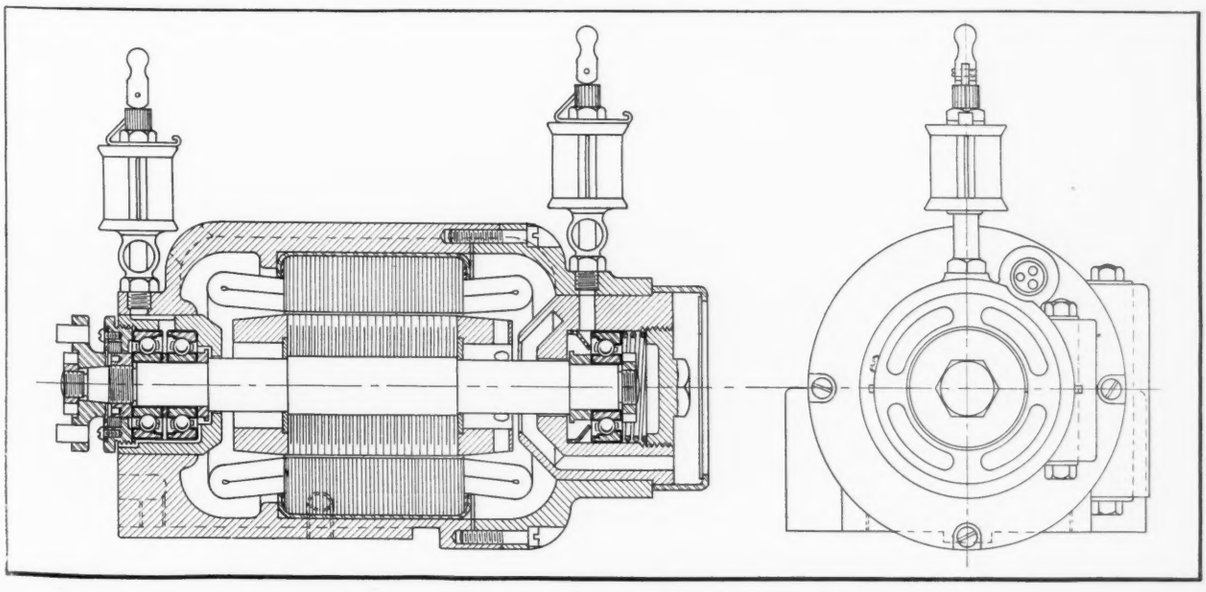


Fig. 5. Arrangement of Angular Contact Bearings for High-speed Motors

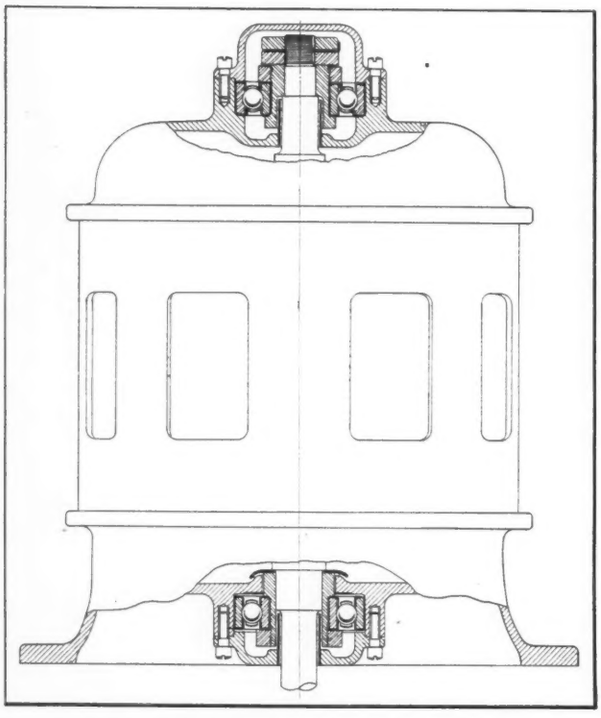


Fig. 6. Vertical Motor having a Quill Type Mounting

the oil is circulated through the upper and lower bearings by means of a small centrifugal pump clamped to the lower end of the armature shaft.

Types of Bearing Closures

A few remarks regarding bearing closures may be of interest. There are three principal types of closures—felt groove, grease groove, and mechanical thrower. The plain felt, which is probably the one most often used, has the disadvantage that wear occurs, and the seal then loses its efficiency. Also, with the solid cast type of groove, the felt is often destroyed and is hard to replace. When a felt is used, an open-type groove with a closure plate, as shown at *A*, Fig. 7, is recommended. This allows ease of felt replacement or assembly; also it should be noted that the width of the lip of the groove at the point where it is most desirable to prevent leakage should be made as wide as possible. This adds considerably to the efficiency of the seal.

The plain grease functions in the same manner as the felt groove, except that the grease fills up the groove and then operates in the same manner as the felt. The advantage of this type is that under pressure caused by rotation, the grease is being continually fed into the groove, thus keeping the seal at its maximum effectiveness. Also, such grease as tends to leak out hardens around the opening between the shaft and the grease groove lip, adding a further protection. The disadvantage is that if the operating temperature is such that the grease becomes fluid, the efficiency of the seal is lost.

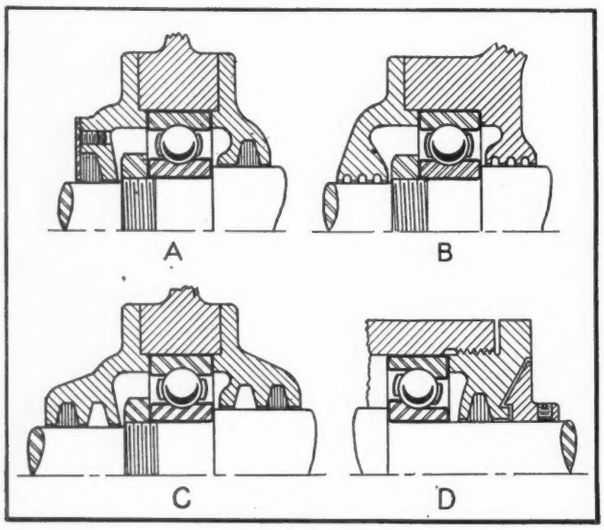


Fig. 7. Types of Bearing Closures

A modification that is often used, which consists of a number of small grooves, is shown at *B*, Fig. 7, and is perhaps, superior, but slightly more expensive, as the grooves must be machined. Such tests as the writer has conducted have shown that combining the felt and grease groove, as shown at *C*, gives all the advantages of the two types of closures, and produces a seal that allows either grease or oil to be used, with maximum efficiency.

The mechanical-thrower type, as illustrated in Fig. 9, should be used for high speeds only. As its success depends on the centrifugal force caused by rotation, it cannot be used where the oil level is carried above the shaft diameter. Its use is not recommended for anything except high-speed spindles and, perhaps, when used on the exterior of a felt or oil groove seal with the motor operating under conditions of extreme dirt. This mounting, illustrated at *D* in Fig. 7, is very efficient under these conditions.

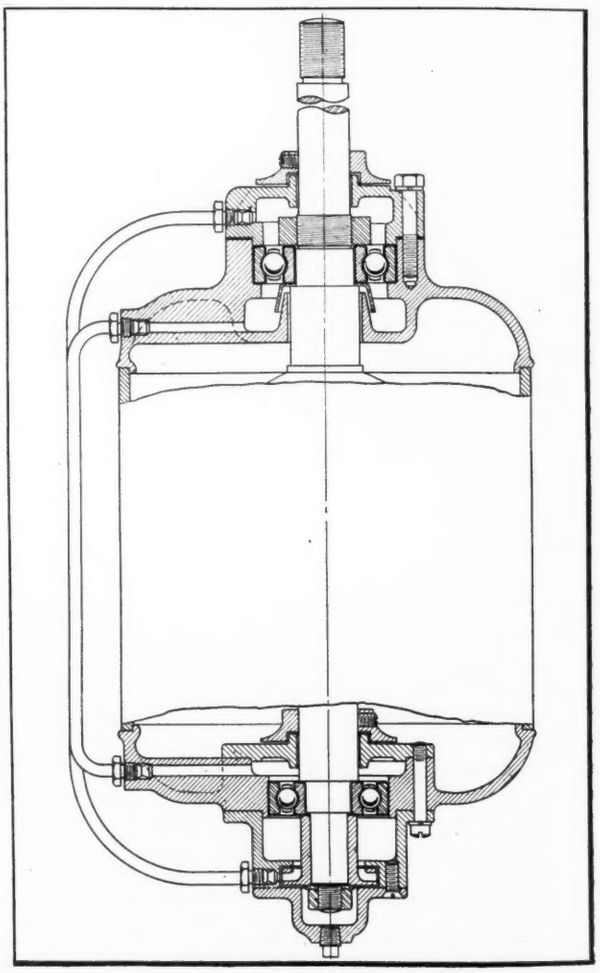


Fig. 8. Circulating Oil System for High-speed Vertical Motor

Ball Bearing Lubrication

As to lubrication, grease is recommended for speeds up to 4000 revolutions per minute. In using oil for high speeds, very small quantities must be fed; otherwise, heat will be generated due to the churning action of the cage used to space the balls. Lubricants containing graphite should not, under any circumstances, be used in ball bearings. It has been found that graphite will harden and pile up in the raceways, causing little hills over which the balls have to ride, and will eventually cause the balls to wedge and one

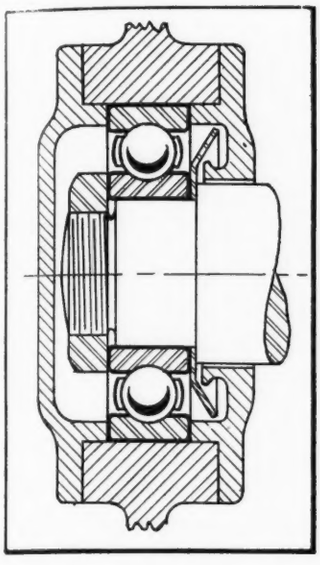


Fig. 9. Mechanical-thrower Type of Bearing Closure

of the races to turn around while the balls and other race are jammed stationary.

Concerning the make and type of lubricant, nearly all the large oil companies now publish a table showing greases and oils recommended for various speeds and operating temperatures. This table is similar to the kind that has been published for automobile lubrication, in which the lubricant best suited for a certain make of car is described. It is suggested that the users of ball bearings, whether in electric motors or in general machinery, secure copies of these charts, find the lubricant best suited to their needs, and have its application approved by the manufacturer.

* * *

GRADUATING SHRINKAGE SCALES

By GEORGE A. LUERS

In pattern work, allowance must generally be made for the shrinkage of castings. This means that the pattern must be made somewhat larger than the actual dimensions in order to obtain a casting of the required measurements. Pattern workers' scales for materials such as cast iron, brass, and cast steel are usually available, but for special aluminum alloys, zinc, and various other metals, it is necessary to provide scales graduated to correspond with the shrinkage characteristics of each metal. If the amount of shrinkage of a bar 1 foot long is determined, it is possible, by means of a standard scale, to graduate a special scale for use in making patterns for castings of the same material as the bar.

To graduate the special scale *A* shown in the accompanying illustration, a square *B* or a T-square is used in connection with a standard scale *C* to draw parallel lines on a blank sheet of drawing paper, as indicated in the illustration. The scale *A* to be graduated, which is usually a piece of thin wood or a strip of aluminum, is placed in an inclined position on the parallel lines. The total length *X* of the part to be graduated is 1 foot plus the amount of shrinkage. The graduations are made on this scale for each corresponding increment of the standard scale. This method of graduating is also used in making scales to measure prints drawn to a metric scale, photostat reproductions, or drawings made to any unusual scale.

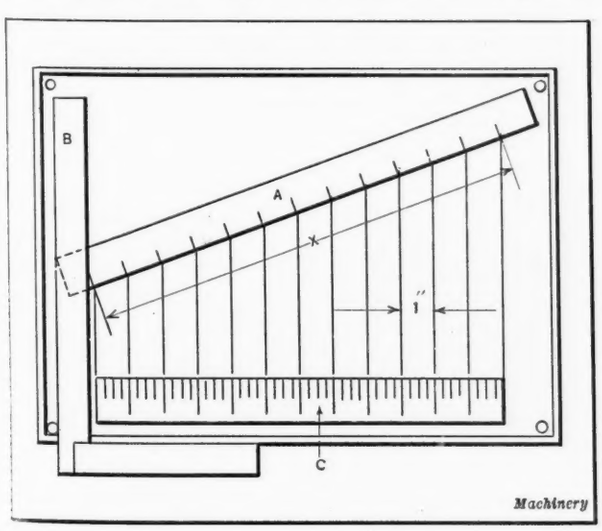


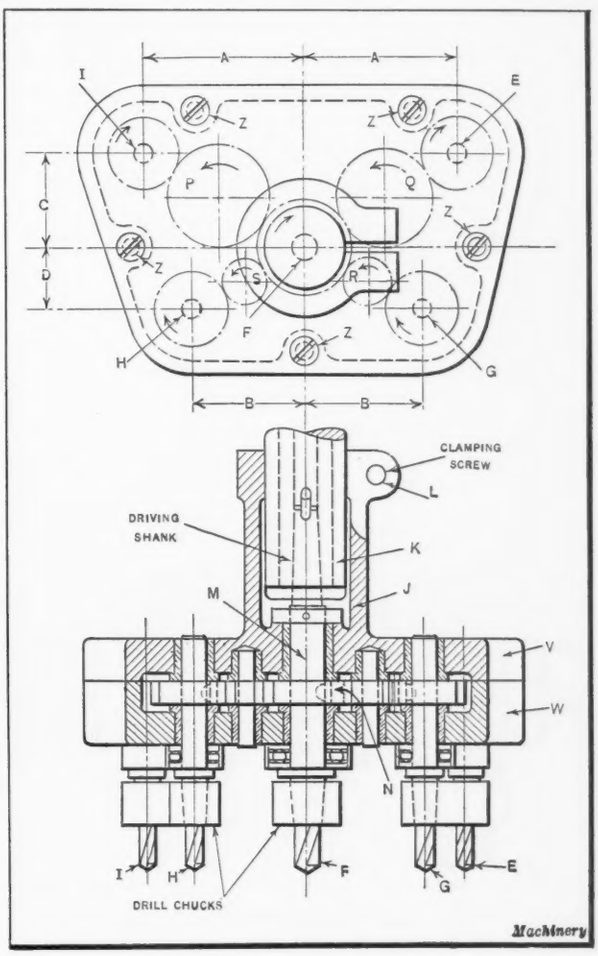
Diagram illustrating Method of graduating Shrinkage Scale

* * *

MULTIPLE-SPINDLE DRILL HEAD

By FRANK H. MAYOH

In the accompanying illustration, is shown a five-spindle drill head, which carries five drills *E*, *F*, *G*, *H*, and *I*. As indicated by the arrows in the plan view, these drills all revolve in the same direction, a necessary feature when standard drills are used. This is a factor that is sometimes overlooked by the designer. The drill head holder *J* is clamped to the sleeve of the drill press *K* by the screw *L*. Fitted in the revolving spindle is a tapered shank, the end



Multiple-spindle Drill Head

M of which serves as a drill spindle for the drill *F* and as a driving shaft for the other spindles.

On spindle *M* is mounted a gear *N* that drives a series of intermediate gears *P*, *Q*, *R*, and *S*, which, in turn, drive the gears mounted on the various drill spindles. In laying out drill heads of this type, the center distances *A*, *B*, *C*, and *D* are first determined, after which the gear drive is built up to suit these positions. The flanged portion *V* and the sleeve *J* comprise the main part of the drill head, while the cap *W* covers the gears and acts as a lower bearing support for the drill spindles. Bronze bushings are used in combination with ball bearings of the thrust type for the spindle bearings. In assembling the drill head, the spindles are first mounted in part *W*, after which the gears are put in place and the entire unit attached to the upper member *V* by means of screws *Z*. This construction provides a dirt-proof casing for the gears.

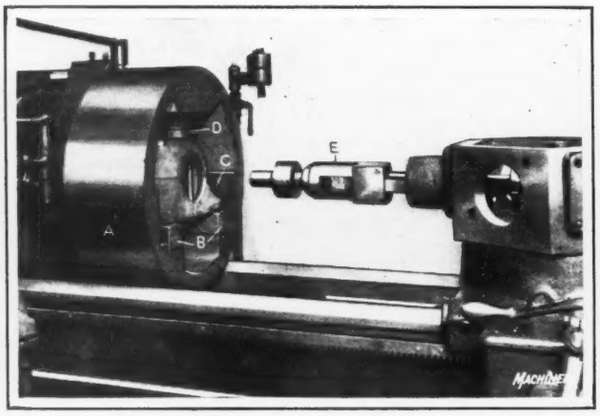


Fig. 1. Special Chuck and Spherical Boring-bar used in machining Pillow Blocks

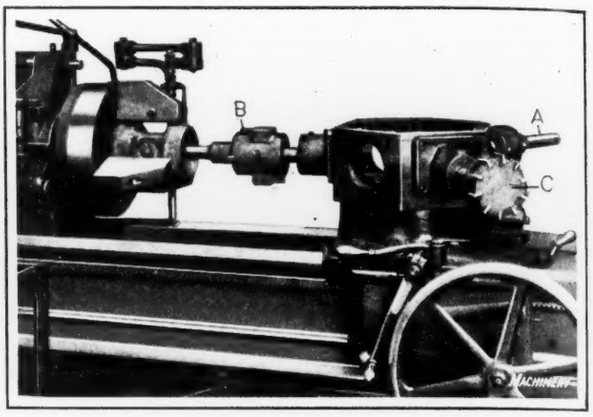


Fig. 2. Special Chuck and Standard Tools used in finishing a Shaft Hanger Bearing Housing

Spherical Turret Lathe Operations

Turning and Boring Ball and Socket Surfaces on Pillow Block Parts

By CHARLES O. HERB

BUILDERS of turret lathes carry a large supply of standard tool-holders and similar accessories in stock, which they recommend for use on more or less standardized operations. However, there are numerous jobs that require the development of special tools for use in conjunction with the standard ones. This was found to be the case in tooling up Warner & Swasey turret lathes for machining two castings used in Dodge-Timken ball and socket pillow blocks. These pillow blocks, as made by the Dodge Mfg. Corporation, Mishawaka, Ind., are fitted with two Timken tapered roller bearings. The special turret lathe tools are necessary for boring two spherical socket surfaces, such as shown at *A*, Fig. 4, in the pillow blocks, and for turning two ball surfaces *B* on the inner bearing housings which fit the pillow blocks. It was also necessary to design a special chuck for holding the pillow blocks while the operations referred to were being performed. This chuck is illustrated at *A*, Fig. 1.

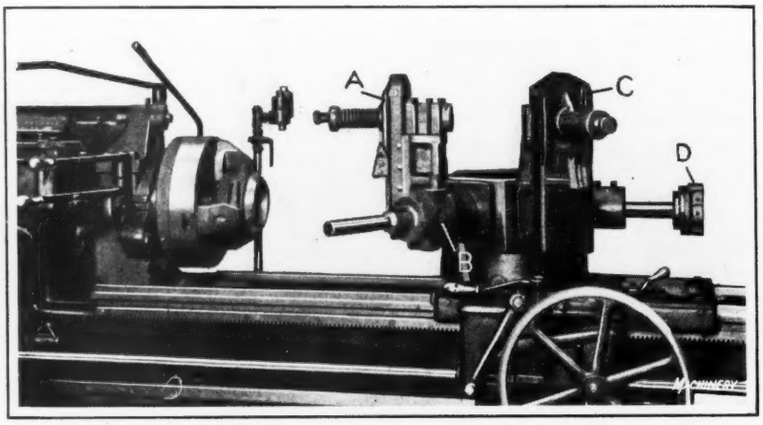


Fig. 3. Tooling Equipment used in the First Operation on the Inner Bearing Housing

The cuts on the pillow blocks are taken in a No. 3A turret lathe equipped with the special chuck just referred to, which is adjustable so as to accommodate different sized work. The pillow block rests on two hardened steel rails *B* which may be interchanged with others to suit the job, the blocks being milled on the bottom before they are sent to the turret lathe. There is a fixed stop *C* on one side of the chuck and a similar adjustable stop directly opposite, which abuts against the bolt lugs on each end of the pillow block to prevent it from shifting. Finally, the pillow block is gripped on top by means of a screw-operated clamp *D*. This clamp is beveled and serrated on the side that contacts with the work, and it can be swiveled to insure a good gripping action. It is operated by means of a socket wrench. In proportioning chucks, it is the practice of the Warner & Swasey Co. to make them sufficiently heavy; the one shown in the illustration weighs about 375 pounds.

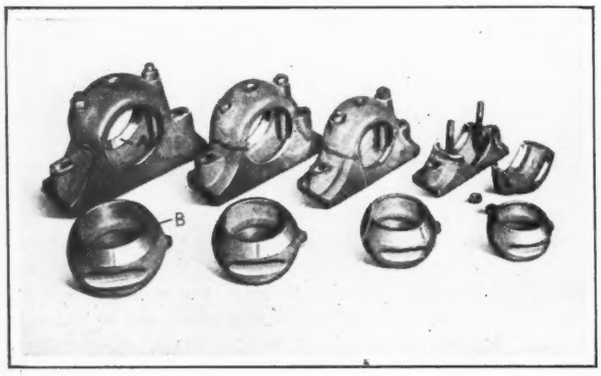


Fig. 4. Pillow Block Parts on which Spherical Surfaces A are bored, and Spherical Surfaces B turned

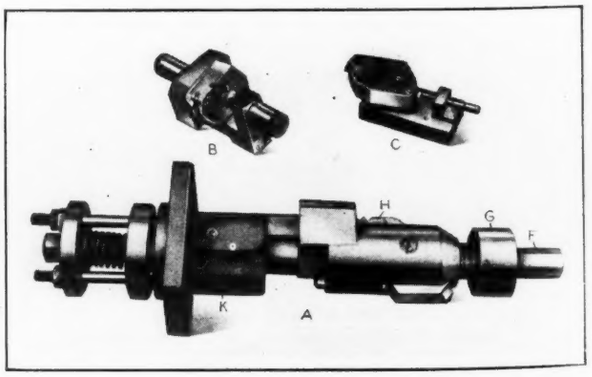


Fig. 5. Detail Views of the Spherical Boring Unit and of a Grinding Fixture and Gage used in Conjunction with it

Spherical Boring Operations

In the turret lathe operations on the pillow blocks, the first step consists of straight-boring the front and rear walls. Then the special boring-bar *E* is employed to rough-bore a spherical surface on the inner side of each wall, after which a similar boring-bar is used for taking finish-boring cuts on the same spherical surfaces. At *A* in Fig. 5 is shown a detail view of this special boring equipment, while Fig. 6 shows it diagrammatically.

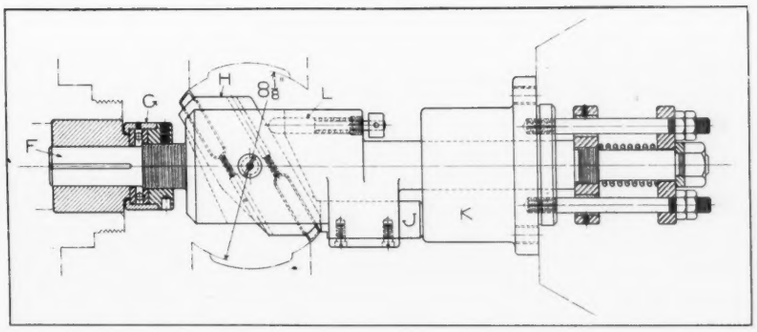


Fig. 6. Details of Construction of the Boring Equipment shown at A in Fig. 5

The boring-bar is guided by pilot *F* which enters a bushing in the headstock spindle until the ball-bearing stop *G* comes in contact with the front of the bushing. This prevents the section that holds the boring tool-block *H* from advancing further, and thus positions the boring tools accurately for the operation. As the turret continues to advance, plug *J* is pushed forward by casting *K*, attached to the turret face, so that the forward end of the plug causes block *H* to swivel on its center and bore the spherical surfaces simultaneously.

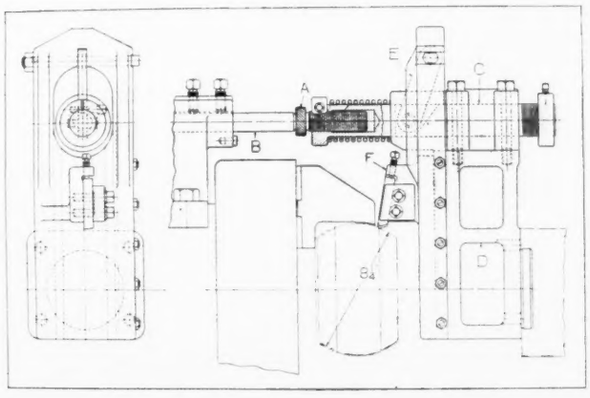


Fig. 7. Construction of the Special Tool-slides shown in Fig. 3

When the turret is returned to the rear of the bed, the spring-actuated plunger *L* causes the tool-block to swivel into its normal position, so that the boring-bar unit can be withdrawn from the work.

The limits of accuracy to which the spherical surfaces are held vary with the size of the pillow blocks, but on blocks bored to a diameter of 5 5/16 inches, the plus and minus limits are 0.004 and 0.000 inch, respectively. Similarly, the production time differs for the various sizes; for the 1 15/16-inch shaft size, the turret lathe time is seven minutes per pillow block, whereas on the machine formerly used for doing this work the time was thirty minutes.

A fixture used for grinding the cutters while assembled in the swivel block is shown at *B*, Fig. 5, the fixture being held between the centers of the grinding machine for the operation. At *C* is illustrated a gage used for setting the cutters to the proper diameter. This gage is equipped with a micrometer device.

Spherical Turning Operations

Two turret lathe operations are required for finishing the inner bearing housings, because of the spherical external surfaces on each end. The tooling equipment for the first operation is illustrated in Fig. 3, the machine being furnished with a differential chuck provided with suitable jaws. The first step consists of rough-boring a seat for a roller bearing with a standard boring-bar, after which slide tool *A* is used for rough-turning the spherical surface on the end of the work projecting from the chuck jaws. In the third step, tool-head *B* finish-bores the seat for the ball bearing and faces the end of the work. Then slide tool *C* finish-turns the spherical surface, and finally reamer *D* sizes the roller bearing seat.

The construction and operation of slide tools *A* and *C* can best be understood by referring to Fig. 7. As the turret advances, the adjustable screw *A*, mounted on the tool-slide, contacts with stop *B* on the headstock of the machine, and

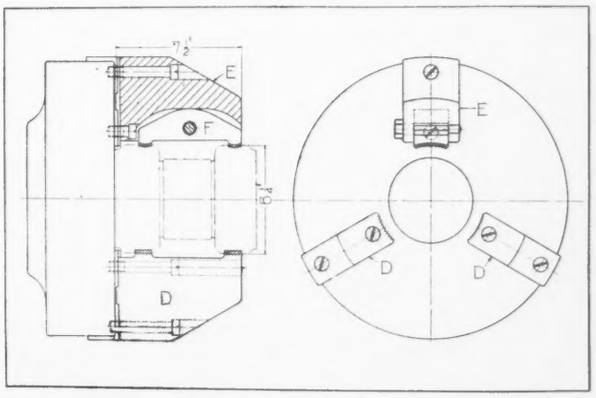


Fig. 8. Details of Construction of the Special Chuck shown in Fig. 2

prevents further movement of rod *C*. Hence as casting *D* is carried forward by the turret, link *E* swings forward and upward and raises tool-slide *F* at the proper rate of feed to turn the spherical surface to the desired diameter. It is obvious that longer or shorter links must be used with different sized work.

For the second operation on the inner bearing housing, the finished roller bearing seat in the part is mounted on a stud arbor held in the headstock spindle, being pushed into place by pressing fingers *A*, Fig. 9, against it. The clamps of the chuck are then swung into place and the bolts tightened to hold the work securely on the arbor for the operation.

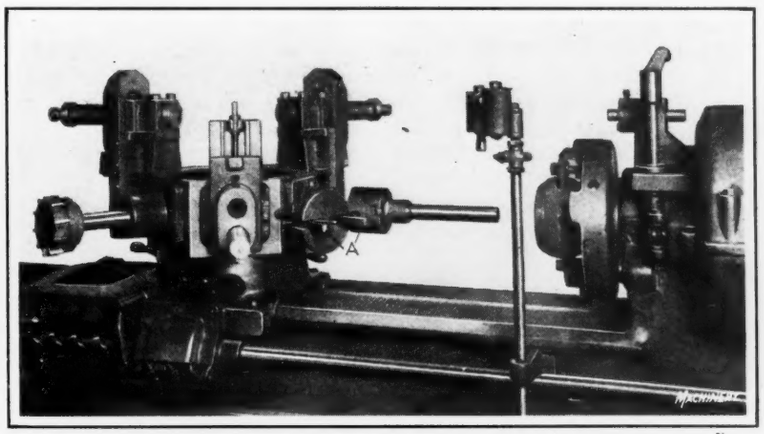


Fig. 9. Tooling Equipment used in the Second Chucking of the Inner Bearing Housing

Cuts identical with those taken on the opposite side of the work in the previous operation are now taken on the side extending from the chuck jaws. On one size of bearing, a groove is also turned. At the end of the operation, the chuck clamps are loosened, and then fingers *A* are entered into the

work and grip a shoulder, so that the work is pulled from the stud arbor when the turret is withdrawn. As the fingers enter the part they are compressed toward each other, and they expand after the shoulder has been passed. The total floor-to-floor time of the two operations on one of the sizes of this part is sixteen minutes, as compared with forty-five minutes required by the method formerly used.

Another Special Chuck Design

Fig. 2 shows the tooling equipment used in a turret lathe for finishing the bearing housing in Dodge shaft hangers. In this operation, the tools on bar *A* rough-bore the housing to receive a roller bearing, while those on bar *B* finish-bore the roller bearing seat, and face and chamfer the end. Reamer *C* is employed for sizing the roller bearing seat. When these three steps have been accomplished, the bearing housing is reversed in the chuck, and the opposite end is finished in the identical manner.

The unusual feature of this tooling is the construction of the chuck jaws, which may be more clearly understood from Fig. 8. The jaws proper are 7 1/2 inches long over-all, and hold pieces about 8 inches in length. Jaws *D* are each made with two series of integral teeth for supporting the housing at the front and rear, but jaw *E* is equipped with a special equalizing link *F*, provided with teeth for the same purpose. The chuck itself is of a standard wrenchless differential design. Six different sizes of bearing housings are handled in the same machine by merely changing the chuck jaws, the boring-bars, and the reamer.

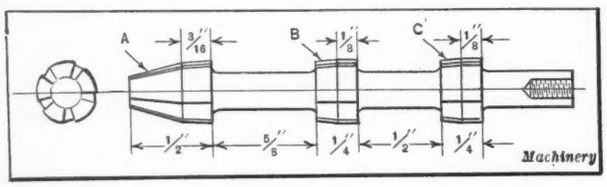
* * *

REAMING SMALL BRASS TUBING

By HENRY T. PRICE

Anyone who has had occasion to ream out brass tubing knows what a difficult job it is, as the tubing invariably becomes so hot that it crumbles and breaks up. The drill or reamer often sticks in the tubing and must be driven out, with the result that either the tubing or reamer is broken. After trying numerous unsatisfactory designs of reamers and drills for removing 0.010 inch of stock from the inside of 1/2-inch tubes, 24 inches long, the writer developed the design here illustrated, which worked surprisingly well.

This reamer has three cutting sections *A*, *B*, and *C*, between which the stock is turned down 5/32 inch to afford



Reamer designed for finishing the inside of Small Brass Tubing

adequate clearance for chips. Section *A* is 0.003 inch larger in diameter than the inside of the tube; section *B*, 0.0035 inch larger than section *A*; and section *C*, 0.0035 inch larger than section *B*. Section *A* is tapered generously for approximately 5/16 inch from the front end, and from this point on to the rear end there is a slight taper. The other sections are also tapered slightly to about 1/8 inch from the rear end, which is made the full diameter. Five straight flutes are cut in each section. At the rear end the reamer is tapped as indicated, in order to permit it to be attached to a long shank.

The reamer is approximately 2 3/4 inches long over-all. It was made of tool steel, heated to a cherry red color, dipped in water, and drawn to a light straw color. It has been used without oil or other lubricant, and may be fed as fast or slow as desired without heating or sticking. Although this reamer has only been used with 1/2-inch tubing, similar designs would doubtless be equally satisfactory for larger sizes of tubing.

RUSTPROOFING OF SHEET STEEL

The extent of the damage due to rust and corrosion of metals was clearly pointed out by Dr. M. E. McDonnell, chief chemist of the Pennsylvania Railroad System, in a paper entitled "Rustproofing of Materials," read before the Altoona meeting of the American Society of Mechanical Engineers. It was mentioned that in his annual address before the American Society for Testing Materials this year, the president of the society, F. M. Farmer, estimated that in this country the loss due to rust and corrosion of metals amounts to $300,000,000 annually.

There is a great deal of activity to prevent this loss. At the spring meeting of the American Chemical Society, an entire session was devoted to the corrosion of metals. The American Society for Testing Materials, the American Electrochemical Society, and other organizations have active committees at work studying corrosion, and a great deal has been accomplished in this direction. The Bureau of Standards at Washington spends 8 per cent of the funds allotted to the bureau, in research to determine the causes and means of preventing corrosion. The Research Department of the Pennsylvania Railroad System has been actively studying rust and corrosion for years, and the protective measures suggested by experiments have been applied on a broad scale.

In considering the effect of the destruction of steel due to rust, it should be remembered that the destruction of 1000 tons of steel means the depletion of our national resources equivalent to 2000 tons of ore, 4000 tons of coal and more than 500 tons of limestone, not to speak of the losses of magnesite, chromite, and manganese, and it should also be remembered that most of the manganese ore now has to be imported.

Preventing Corrosion by Using Copper in Steel

Thirteen years ago the Pennsylvania Railroad Testing Laboratory exposed fifteen commercial steel sheets on the roof of the locomotive test plant in Altoona to weather conditions. In these tests it was found that the sheets containing copper lost less in weight through corrosion than those that did not contain copper, and as a result of these tests, the Pennsylvania Railroad adopted sheet steel containing copper for car roofs. The average life of 22-gage copper-bearing sheets in the tests undertaken was over 49 months, while the average life of plain carbon steel sheets was only 23 months. The results of the tests are fully recorded in the 1923 annual report of the American Society for Testing Materials. In 1920, the Pennsylvania Railroad adopted copper-bearing steel for all sheet steel used in car construction.

Savings Due to Use of Copper-bearing Steel

It is not possible as yet to state definitely what the effect in regard to savings will be through the introduction of copper-bearing sheet steel in car construction, because the destruction of a car is not due entirely to rust. There is some destruction due to abrasion and wear and other causes. But since it is known that copper-bearing steel is more than twice as resistant to atmospheric corrosion as the carbon steel formerly used, it is a conservative estimate to assume that there will be at least a 50 per cent increase in the life of equipment built with copper-bearing steel. Ordinarily, steel freight cars will require rebuilding after from eight to twelve years of service, when made from carbon steel sheets. It costs nearly $20 more to build a car from copper-bearing steel. Assuming that its life is increased from the former eight to twelve years to from twelve to eighteen years, there will be an annual saving of $12 per car. This is a liberal return on the additional investment of $20 per car, which has to be incurred on an average of only once every fifteen years.

The Reason Why Steel Containing Copper Resists Corrosion

Those who have had practical experience with steel may have noticed that ordinary steel forms a light brown, loose

rust on oxidation, while copper-bearing steel oxidizes on the surface to a dense, dark brown, adherent coating, and this is believed to act as a protective measure against rapid destruction. Other similar examples of oxidized protective coatings are well known to the engineer. A bright copper roof has a rapid initial rate of corrosion, but the dark green coating formed on exposure soon retards further progress. Bronze has a rapid initial rate of oxidation, but the beautiful adherent coating arrests destruction. Zinc is readily corroded, but the coating formed protects the base metal. In the selection of materials for engineering structures, the character of the coating formed on oxidation deserves careful consideration. A rustproofing coating may be obtained by the use of a small percentage of an element or ingredient which, on oxidation, produces a protective film.

In the tests cited, special reference has been made to the influence of copper. Other elements present in small quantities also influence the rate of rusting. In the absence of copper, a high sulphur content stimulates corrosion. In the presence of copper, a small percentage of manganese improves the resistance of the protective coating formed on oxidation. The presence of chromium in steel increases its rust-resisting properties, and the so-called "stainless" steel which is now being used for cutlery and other small parts where great rust resistance is essential, contains approximately 13 per cent of chromium. However, various causes, such as the limited amount of chromium ore available, the high cost of its reduction, and the difficulties encountered in rolling stainless steel, will very likely prevent its use for general structural purposes.

Protective Coatings on Steel

The duties of the engineer do not end with the purchase of the best commercial structural metals now available. Steel for important structures, such as bridges, should receive a shop coat of good paint prior to its shipment from the factory, and for this purpose red lead is still a favorite. Steel for rolling stock which is not painted should be stored in a dry place until it can be assembled, and if this is not feasible, a protective coat of some kind should be applied. The method employed by the Pennsylvania Railroad, and by numerous other concerns, is to apply a petroleum oil coating which contains resins and wax, these constituents being added to the oil for the purpose of imparting adhesive properties. On withdrawal of the steel from storage for use, the temporary protective coating is removed.

After construction, exposed steel parts should be well painted. Many technical organizations have devoted a large amount of time to determining the most durable paints that can be applied. Experience teaches that the best air drying paints are those that contain, in addition to the pigments, good oil and a minimum amount of drying constituents, such as japan drier. Paints made in accordance with these precepts dry slowly, and under conditions prevailing in industrial centers, the coating is likely to become contaminated by dirt before the paint film is set. Furthermore, the use of such paints on rolling stock keeps it in the shops for a long time and out of service. Painters know that an excessive amount of driers shortens the life of paint. The action of the driers does not cease when the paint film has become dry, but continues after the purpose for which they were added has been accomplished. This leads to premature destruction of the paint film.

Notwithstanding the known detrimental effect of these driers, painters sometimes use them in excess in order to get the equipment out of the shops in the shortest time possible. Numerous tests were made to solve this difficulty, and it was found that by means of heat, paint films could be dried without the use of artificial driers.

Drying Painted Steel Cars in Special Oven

A laboratory baking oven was constructed, and a large number of painted panels prepared, using different compositions. These panels were exposed on a test rack in comparison with panels painted with the usual air-drying paints and varnishes in use. The panel tests showed that the baked coatings had greater durability than the air-dried ones. The difference was so decided that a baking oven for passenger cars was constructed at the Altoona paint shops.

Cars painted by the baking process require repainting every thirty-six months, while those painted by the air-drying process require repainting at intervals of eighteen months. It requires fourteen working days to paint a new passenger car by the air-drying process, while by the baking process, all of the painting operations can be completed in six working days. Thus, the baking process reduces the time which passenger cars must be retained in the shops on account of painting operations more than 60 per cent.

The ovens are 90 feet, 3 inches long, and will accommodate the largest cars in service. They are equipped with ventilators, and are heated by steam under a pressure of 125 to 150 pounds per square inch. Each oven contains 2000 square feet of radiating surface. Temperatures of from 250 to 260 degrees F. are maintained. Baking paints, as well as the priming and surfacing coats for passenger cars, are dried in three hours at these temperatures. Varnish and light colored enamels used for the final coats on passenger cars darken at high temperatures. They are dried in three hours at temperatures of from 150 to 160 degrees F.

The coatings as applied to passenger cars by this method have been found to be very durable. All steel passenger cars from which it is necessary to remove the old paint are sent to Altoona to be repainted by the baking process.

How Steel Freight Cars are Rustproofed

In addition to the baking of paint coatings on passenger cars, the method was applied to some eleven hundred freight cars in 1913. These were coal cars which were in need of paint. They were given one coat of baking paint in which different oils were used, including Menhaden fish, corn, cottonseed, and soya bean oils, with linseed and China wood oils. None of the paints used contained artificial driers. The cars were repeatedly inspected for about five years, and the results obtained were so satisfactory that baking ovens were authorized and built at the Pitcairn shops in 1923.

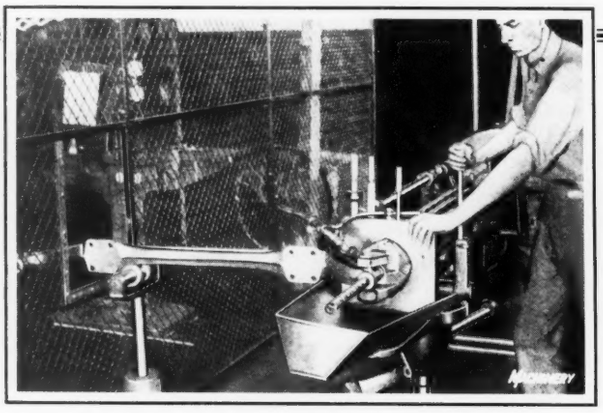
Freight cars receive two coats of paint, each coat being baked from 2 1/2 to 3 hours. The paint is sprayed on the cars. It is possible by this method to apply two coats of paint and stencil the cars in one working day, employing two shifts of men. No artificial driers are added to the paint used, and a large percentage of Menhaden fish oil is used in thinning the paste paint, which is ground in linseed oil. A small percentage of China wood oil is used, as tests and experience indicate that this addition increases the water-resisting properties of the paint film. It is estimated that the time saved in painting cars by this operation is two days. In other words, the cars are available for two more days revenue service. By this method of painting cars, unexpected delays due to failure of the paint to dry on account of bad weather conditions is not experienced.

Lacquering Methods of Rust Prevention

The extension of the baking system for passenger cars to other shops has been deferred pending the outcome of tests being conducted with the lacquer system which has recently revolutionized the method of painting automobiles. These lacquers contain a colloidal solution of nitrated cotton and varnish gum in a mixture of volatile solvents, which usually include ethyl acetate, anhydrous alcohol, benzine or toluene, and other volatile constituents. Pigments are incorporated with this solution to give the desired color, and to make the resulting film durable. Lacquers of this type dry so quickly that they cannot be satisfactorily applied by means of a brush. They are applied with spray equipment. The Pennsylvania Railroad now has five passenger cars and over a hundred locomotives which have been finished with lacquer. Lacquer coatings have so far proved to be satisfactory and durable, and they can be cleaned more easily than varnish coatings.

How the Automotive Industry Selects Equipment

Last of a Series of Three Articles Dealing with Important Factors Considered by Equipment Engineers in Selecting Machine Tools, Small Tools, and Tooling Equipment for the Production of Automobiles, Trucks, and Tractors



Broaching the King-pin Hole in the Front Axle of a General Motors Truck

IN the first article of this series, published in October MACHINERY, the general principles that guide the equipment engineer in the selection of machine tools for the automotive industry were outlined, and the question "How long should it take the savings due to increased production to pay for a new machine?" was answered.

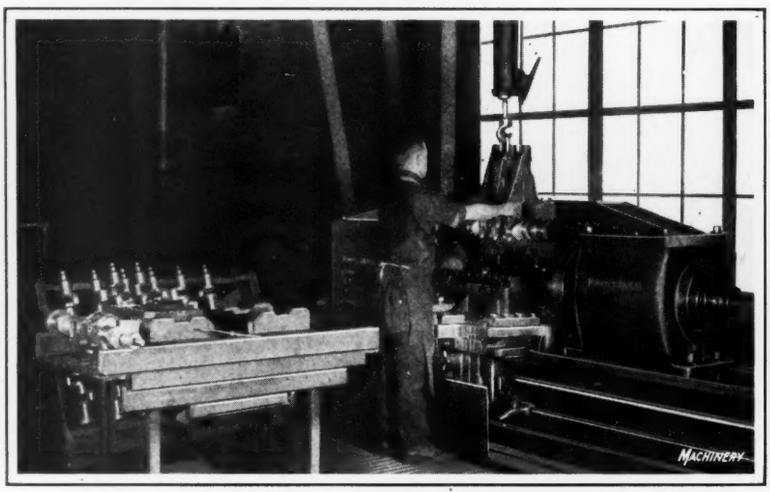
In the second article, which was published in November MACHINERY, the subjects dealt with covered the procedure in selecting new equipment; the duties of the estimating department and the methods whereby it approaches the subject of comparative cost investigations; and the selection of different classes of machine tools, including turning machines, milling machines, drilling machines, gear-cutting machines, and grinding machines. Some interesting information was included on the subjects of the cost of dressing grinding wheels and the total cost of grinding wheels in the automobile industry.

The present article—the concluding installment of this series—will deal with the selection of small tools—taps, drills, milling cutters, and reamers.

Selecting Small Tools by Careful Tests

In order to obtain small tools that will give the best results, a number of firms in the automotive field have made tests on different makes of tools and have established as a standard the make or makes giving the best service. The best tool is that which gives the lowest production cost per piece, and frequently higher priced tools are bought because they will perform more operations per tool. Thus, for example, the cost of taps and drills is not gaged by the cost per tap or the cost per drill, but by the cost per tapped or drilled hole. After tools of a tested make have been in use in the shop for a certain period, half a dozen tools are frequently bought from some other manufacturer for the purpose of comparison, and in that way the best quality of tools for given manufacturing conditions and materials to be worked upon are determined.

When trials are made with tools of different manufacturers, the manufacturer's name is frequently removed from the tool, in order to prevent any preconceived ideas on the part of the operator or the foreman from interfering with a fair trial of the tool. In some plants, it is customary to standardize on at least two different makes of tools, so that there will be two sources of supply. By carefully balancing quality and price against each other, there is no danger of over-emphasizing either factor. The purchasing department may be depended upon to carefully look into the price; the shop, in most automobile plants at least, is given a right to determine what quality it requires. If the quality falls off, the business in most cases is lost, irrespective of price.



Special Tooling Equipment for an Engine Lathe which paid for itself in a Few Months

Performance Record of Tools

A number of shops keep accurate detailed records of the performance of small tools, so that, should the quality of any given make deteriorate, or should a certain batch of tools happen not to be equal to the general standard, it will be immediately noticed.

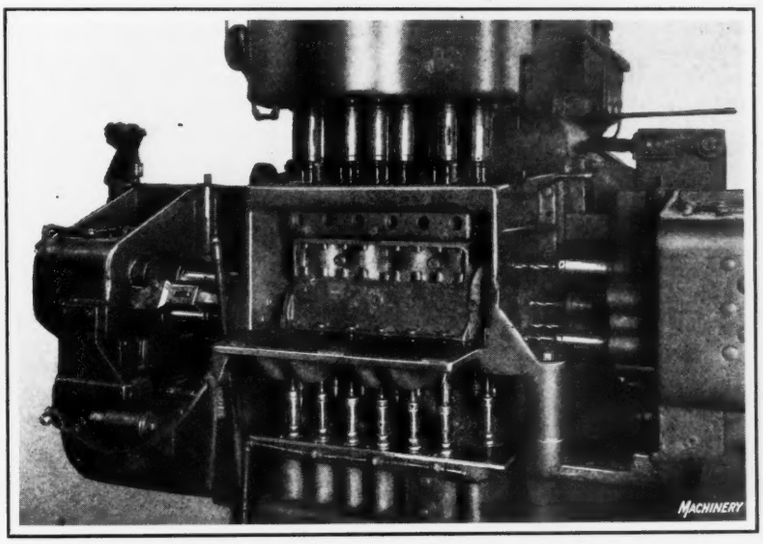
In a large truck manufacturing plant, very accurate performance records are maintained for all small tools, such as taps, drills, milling cutters, hobs, reamers, files, and hacksaw blades, as well as for grinding wheels, cutting steels, and cutting compounds. These records contain practically all the information required to describe the tool, the work operated upon, and the conditions under which the test of the tool or the steel, grinding wheel, or cutting compound was conducted. By making such tests frequently and studying the performance records, it has been found possible to standardize upon certain types and makes of small tools and supplies with an assurance that the best tool or material for the purpose is being used. In the following pages, the details specified in these performance records for taps and drills are recorded.

In one plant, the cost of tools was reduced in a few months by nearly 50 per cent through keeping careful records of the results obtained with different tools, and investigating the reasons for breakages. A

certain standard for tool costs has been established for each department. If the tool costs goes up, the cause is determined. Each week a report is made by the tool supervisor to the factory manager covering any points in the use of small tools that do not appear to be satisfactory. If the quality of the tools is at fault, the seller of the tools must either improve the quality of future deliveries or lose the business. Incidentally, it might be mentioned that the records of this plant show that 12 1/2 per cent of the total cost of small tools is accounted for by tool breakage.

The High-speed Steel Ground-thread Tap

In regard to taps, the subject that interests most production engineers at this time is the efficiency of the high-speed ground-thread tap. Perhaps the opinions of production men in different plants can best be conveyed by quoting verbatim from the expressions of a number of engineers. Says the tool engineer of one plant: "High-speed steel ground-thread taps are a good investment for certain work. In this plant, we use them especially for tapping cast iron. We do not use them very much for tapping steel. For cast iron they last much longer, however, than carbon steel taps. They appear to resist the lapping effect of the cast-iron chips and oil. The saving in cost is due to several factors. They last longer, and they do not break so easily; hence, time is saved, especially in multiple-spindle tapping where, if one tap breaks, there is an inevitable loss of time from many idle spindles while the tap is being changed. On account of the expense of high-speed taps, great care should be taken to prevent breakage. This can be done in most cases by using an efficient friction tap-holder."



Drilling Forty-eight Holes at One Time in the Ford Cylinder Block

Another tool engineer says: "High-speed steel ground taps cost about 80 per cent more than carbon steel taps, but they will tap from four to five times as many holes. They give us accuracy as well as production, and hence they are cheaper in the long run."

In a plant where practically all the taps used are of the ground-thread type, the equipment manager said: "We find ground-thread taps cheaper for every kind of tapping. They have much longer life, both because they wear better and because they do not break so easily. They give use the accuracy we require. We do a great deal of finishing tapping with low-tungsten steel taps, which appear to be capable of extreme hardness, and hence produce a smoothed tapped hole. In machine tapping, by using high-speed steel ground taps, we have eliminated the need for a second finishing tapping. The ground-thread tap will cut right to size and leaves no rough or torn threads."

Conflicting Opinions on the Best Uses for Ground-thread Taps

Accurate information as to the best application of ground-thread taps seems still to be lacking, because, while one tool engineer as quoted above, states that his firm uses high-speed steel ground taps mainly on cast iron and only to a small extent on steel, another states that in his plant ground thread taps are used mainly on steel and aluminum, because they produce a better finish and do not tear the threads.

Another equipment engineer, expressing an opinion running counter to that of the majority, makes use of ground-thread taps for accuracy only. He states that they have not been found cheaper for general tapping purposes, although careful tests have been made to determine this. The trouble his firm has encountered is that the breakage of the expensive high-speed steel ground tap outweighs the savings due to its long life.

Commenting on this opinion, another tool engineer said: "If the breakage cost of ground-thread taps cuts into the production cost, the fault is not with the tap, but with the machine or the tap-holder; it is usually the machine and the holder that should be investigated rather than the tap, when frequent breakage occur. The same is true when a tap cuts larger than its own size. Different methods of holding the same tap will make it cut two entirely different sized threads. On multiple-spindle drilling machines, for example, the tap should be considerably smaller in pitch diameter than the hole to be tapped. There are some cases, especially on steel, where high-speed steel taps, not ground, might produce a cheaper product per hole tapped, but this is a matter that would have to be carefully investigated in each case."

There is only one of the larger automotive concerns that does not use high-speed steel ground taps to any appreciable extent. In this case, it is stated that experiments have proved these taps to be too expensive for the advantages gained. It is obvious, therefore, that there is still room for more definite information on the value of ground-thread taps. However, it is generally conceded that this type of tap is cheaper for high-production work.

As an indication of how completely some automotive firms keep a performance record of the taps used, the following description of the records kept in a truck manufacturing plant may prove of interest. A sheet is provided on which is entered, for each class of taps used in the plant, its size and classification, cost, whether made from carbon or high-speed steel, whether threads are ground or unground, number of flutes, length of flutes when tap is new, name of maker and other identification or brand of tap, name and identification of work on which tap is used, number of holes per piece, Rockwell hardness reading of work, Brinell hardness reading of work, depth of hole, whether blind hole or tapped through, number and kind of threads, and material threaded.

Then follows in the record the following information regarding the tap: accuracy of lead, accuracy of thread angle, pitch diameter of tap when new, pitch diameter of tap when worn, length of chamfer, Rockwell hardness reading of tap, whether relieved or not in the angle of the thread, and whether over-size when new. Finally, the tapping record is entered, giving number of holes tapped while tap still maintained its size within prescribed limits, tapping speed in revolutions per minute and in feet per minute at the pitch line, number of holes tapped per grind, number of holes tapped per 0.0001 inch wear, number of holes per dollar of expense, tapping compound used, tapping chuck used, and condition of machine in which test was made. Then follow conclusions on the part of the investigator.

The report is dated when experiments were started, and when finished; the departments where the experiments were

made is recorded, and the investigator's name is signed to the report. With such a careful record on file, it is possible to compare taps of different makes with each other, and also to compare taps of the same maker made from different materials, or by different methods.

Characteristics of Twist Drills

In reference to drills, it is stated by some production engineers that a smooth finish in the flute, almost a polish, is of great value. A smooth finish on the cylindrical surface is also essential. Polished flutes are especially important in drilling brass, aluminum, and cast iron, and in deep-hole drilling, because the chips come out of the hole more easily. It does not appear to be so important to have a polished flute for drilling steel, as the steel chips themselves tend to polish the surface of the drill.

For many jobs it has been found necessary to have special drills designed. Experiments have shown that drilling is often greatly facilitated by the lead of the spiral having a certain relation to the material being drilled. As yet, however, sufficient experiments have not been made to enable any rule to be formulated. Experiments are made in cases where drilling difficulties are met with, and experience with past drilling jobs is largely drawn upon for suggestions as to what the remedy should be.

In core-drills, many tool engineers prefer those with interchangeable tips. Steel is saved in this way, as only the cutting part at the end of the core-drill needs to be replaced.

Milling Cutters Require Careful Attention

At least 50 per cent of the milling cutters used in the automotive industry are special, made either to the design of the automotive manufacturer, or designed by the cutter manufacturer to meet the needs of the automotive shop.

Several equipment engineers feel that milling cutters are the most difficult small tools to buy. There have not been enough investigations made on the performance of milling cutters to determine definitely upon the best form or type for different conditions. For example, there is a great variety of inserted-blade milling cutters, practically every maker having his own design. Generally speaking, only one, or at best only a few, of these designs can be wholly satisfactory, and it would be of great advantage to the industry if it were possible to determine which design is best, and then to have the entire industry standardize on this type.

Even the pitch or number of teeth in cutters for different services is still an open question, and it is almost necessary to experiment with every job in order to decide on the right number of teeth and the cutting angles of the teeth. The only guide yet available seems to be past experience with similar jobs, and in this respect the experience of the milling cutter manufacturers has proved most valuable. Could this experience be crystallized and standards developed on the basis of it, a great service would be performed.

In view of the fact that what might be called the right cutter for the job will always produce a much larger number of pieces between grinds than other cutters that are not quite suited for the work, it is evident that great savings could be made in the automotive industry, as well as in any production industry, if the requirements for the best type of milling cutter for different conditions could be definitely laid down. One of the greatest items of expense in connection with milling is delay in changing cutters for grinding.

Performance Records of Twist Drills and Milling Cutters

Similar records to those described for taps in a previous section of this article are made in the plant mentioned for the performance of twist drills and milling cutters. In the case of twist drills, this record states the size of the drill, its trade designation, the name of the maker and the type of drill (whether high-speed steel, carbon steel, constant twist, or increased twist), web thickness at point, web thickness at end of flute, width of land, Rockwell hardness test on drill, Rockwell hardness test on work, Brinell hardness test on work, diameter of drill, length of flute, identification of piece to be drilled, material to be drilled, number of holes per piece, blind or through holes, depth of hole, whether starting through scale or through a finished surface, speed in revolutions per minute and in feet per minute, depth of cut, number of holes per grind, number of holes per drill, whether machine or hand feed, cutting compound used, type of machine used, and class of operator.

To this the investigator adds his own remarks and recommendations, and gives the date when the tests were started and finished and in which department they were performed. Much the same information is given on the performance records for milling cutters.

The Selection of Reamers

In the automotive industry, standard reamers are used to a comparatively small extent, and in a great many instances reamers made especially for the job are ordered. In this way, it is possible to obtain a reamer that will meet the conditions in the most satisfactory manner. It can be made of the right length, and with the right number of flutes, designed to give the best cutting action. Several of the large automotive concerns design their own reamers and have them made to their drawings. What is the best reamer to use in each case is largely determined upon by experiments. As yet there is comparatively little information on record that would make it possible to design a good reamer for a given job without some preliminary tests. In making these experiments, different rake of the cutting edges, different flutes, different amount of chip clearance, and spiral and straight flutes are tested.

While some tool engineers consider that milling cutters are the most difficult small tools to select, others hold that reamers are most difficult to adapt to the work. Generally, reamers give more trouble in the shop than any other small tool. Investigations as to what is really required in reamer design are urgently needed, and then certain standard features should be adopted. At present, every foreman and tool engineer has very much his own ideas as to how a reamer should be made. This is especially true in the case of inserted-blade reamers.

If the reamer has a keen cutting edge, it will finish the first holes smoothly, but as a rule, a very keen edge cannot be maintained, and the size of the reamer is soon lost. Because of the difficulties of maintaining the size of reamers, diamond finishing tools have been adopted for the finishing of certain holes, especially for connecting-rod bronze bushings as well as crankcase bushings. The diamond is an expensive cutting tool, but it gives an unusually fine surface, and it lasts for a long time. In one shop, diamonds used for finishing connecting-rod bushings are not reset any oftener than every six months. A bushing given a high finish by means of a diamond tool and a lapped crankshaft bearing produces a combination that can hardly be surpassed.

The Selection of Broaches

Broaches must almost invariably be designed for the job for which they are intended. The teeth should be designed in accordance with the amount of material to be removed. Some automotive manufacturers design their own broaches to suit each job, and then have the broaches made by a tool shop or a broach manufacturer. In designing broaches, it is important to see that there is not too much material for each tooth to remove. If there is, there will be an excessive amount of breakage of broaches, increasing the expense of this operation very much. The speed of broaching is not the only thing to consider, because high speed may cause high breakage, with the result that the cost per piece will be greater than it would be if the production were less.

In making broaches, there should be a liberal fillet at the bottom of the chip space, and the back of the cutting edge of each tooth should be highly polished. This improves the cutting action greatly.

Question Marks in Machine Design*

By FORREST E. CARDULLO, Chief Engineer, G. A. Gray Co., Cincinnati, Ohio

Forrest E. Cardullo

ALL problems arising in the design, construction, and use of machinery ought to be solved by a rigorous and thorough analysis of the engineering elements involved. However, every engineer who has undertaken to solve many such problems knows that it is often impossible to express the problem as a mathematical equation or series of equations. If, in order to escape this difficulty, the engineer adopts a more general process of reasoning, he finds it equally impossible to assign proper relative importance to elements that usually have no apparent relation and that are often in serious conflict. He is compelled to choose between trains of analysis which lead to different conclusions, because they are based on different sets of premises, and his difficulty lies in the fact that he knows that both sets of premises have in them large elements of truth. The engineer is therefore driven to supplement his analysis by judgment, deciding each knotty element of his problem in accordance with the aggregate of the impressions relative thereto, produced in his mind by his past experience. The difficulties outlined arise from four sources:

First, the mathematical treatment required to solve the problem may be too difficult to permit of a solution by the engineer, or even too difficult to permit of a solution by any present-day mathematician. For example, a designer may be forced to give a complicated form to a part subject to known loads, and because of this complicated form, the stresses and deflections produced do not permit of computation.

Second, the conditions of service may not be predictable. No one can tell what feed, depth of cut, hardness of material, and sharpness of tool an operator may use when he does a job in a machine tool. The assumptions of the designer are a guess, pure and simple. He cannot give a satisfactory reason for his assumptions. No bridge engineer can tell how hard the wind will blow, nor can any architect tell how much a snow load will actually be, nor how heavily a floor will be loaded.

Third, the requirements of service may not be predictable. Who can say that a deflection of 0.005 inch in a machine member is permissible, while a deflection of 0.007 inch is too great. By what process of reasoning does an automobile designer arrive at the conclusion that a level still air speed of 60 miles per hour is all right, but 55 miles is too low and 65 miles is too high?

Fourth, the conditions of service may be fully known, and the elements may be calculable, but the correct answer for one set of conditions may be entirely wrong for another set of conditions. For example, consider a shaft that is required to run at speeds of 50 revolutions per minute, and of 1000 revolutions per minute. The proper lubrication for one speed is entirely incorrect for the other speed; also, the best running clearance for 1000 revolutions per minute is entirely too great for 50 revolutions per minute.

As a result of these difficulties, the designer is frequently obliged to base his design entirely on judgment. Two designers of equal ability will produce two entirely different designs, and if both are candid, each will admit that both designs are equally satisfactory, and furthermore, that neither design is what he would like it to be.

Guesswork in Machine Design

Because of these facts, a great many people who are incapable of attempting an analysis of engineering problems believe that they are justified in solving such problems by the use of judgment alone. They do not follow the methods of the engineer, who makes limiting assumptions, and then by various trains of reasoning arrives at a limited field in which his answer must lie, choosing his answer within that field by a judgment in which only those experiences that bear on the problem and that are known to be in accord with the laws of science have any weight. Their procedure, on the contrary, is to collect all the impressions that are suggested to their mind in connection with the problem, by any mental process whatever, whether it be association of ideas, similarity of words, the likeness of function, or what not, and then out of this hodge-podge of impressions to arrive at a conclusion that may be, and often is, far from correct. To put it plainly, they substitute guesswork for analysis, and chance for judgment.

If engineers were obliged only to deal with one another, they would seldom encounter trouble from such loose habits of thought, but since engineering products must be sold to and used by people incapable of engineering analysis and unused to logical thought, the engineer, and particularly the sales engineer, must take account of it. In fact, the sales engineer finds that engineering products must be designed with an eye to sales, as well as to service.

An Example of Opinions Based on Guesswork

In order to discover the extent of such loose habits of thought, and of their probable effects on engineering design, the writer formulated the following hypothetical design problem, and asked the opinions of a number of persons—engineers and others—all of whom had had mechanical experience, regarding a possible solution. The cross-rail of a planer carries a head for mounting the cutting tool, which weighs several hundred pounds. Ordinarily this weight is not sufficient to deflect the rail a measurable amount, so that the work will be practically flat when the finishing cut is taken. However, if the length of the rail or the weight of the head be greatly increased, as, for instance, in designing a planer type of grinder for very wide surfaces, this is no longer true, and the problem is presented of guiding the wheel in a straight line in

In this article the author discusses a number of errors in machine design that require consideration and correction. It has not been the intention to make a survey of all such errors, but rather to point out the fact that a great many people who do not think logically about engineering problems continually influence engineering work as customers for and users of engineering products. It is also pointed out that, in some cases, engineers themselves fall into careless habits of thinking on engineering subjects, and accept, without question, time-worn errors.

*Paper presented before the Machine Shop Practice Division of the American Society of Mechanical Engineers at the annual meeting in New York City, December 1 to 4.

spite of the deflection in the rail produced by the moving load. One solution of the difficulty is to truss the rail in the manner illustrated in Fig. 1, putting an initial tension in the truss rod just sufficient to keep the path of the wheel practically straight as the heavy head passes across the rail.

When the matter was presented to them, the engineers all admitted that this was an effective solution of the problem, but were mostly of the opinion that prospective customers would regard the device as a bungling attempt to remedy a defect that ought not to exist, and suggested concealing the truss rod as a satisfactory solution of the problem of sales resistance.

The machine users did, without exception, take exactly that view of the proposed device. They all demanded to know why the rail should not be made stiff enough so that there would be no deflection. Some of them refused to believe that this was not possible, *and maintained that any deflection in a machine tool member was due to "lack of rigidity."* Further questioning elicited the idea that rigidity meant absolute immobility, and that the lack of this quality was due to some defect in the design, material, or workmanship of the structure. Several of those interviewed stated that they preferred the rail without such a device, because it would strain the metal, not realizing that the strains produced would be equal and opposite to those imposed by the weight of the moving head, and therefore would leave the rail casting free from strain under the conditions of service.

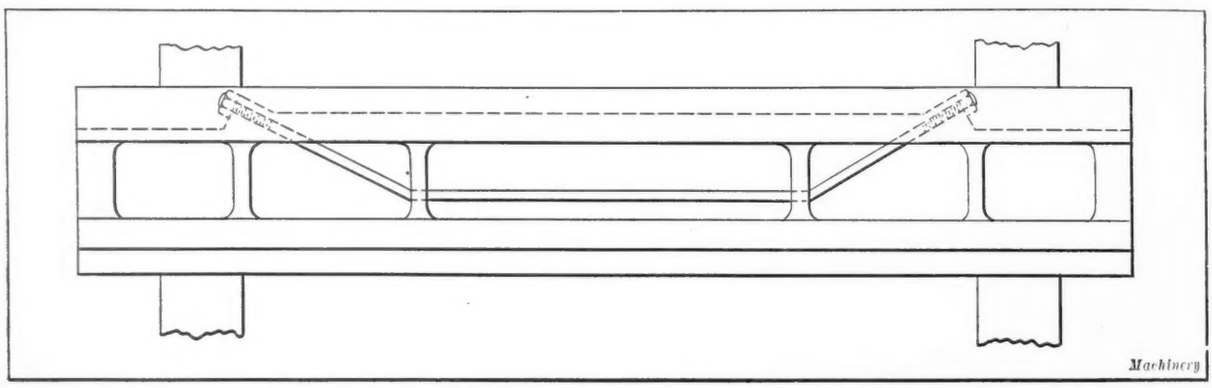


Fig. 1. An Example of Design Correct in Principle but Objectionable because of the Impression created in the Minds of Non-engineering Purchasers

The Difficulty of Machine Foundations

It is more often, however, that the engineer encounters the effects of such loose thinking in the erection and use of engineering products. One of the things that gives a great deal of trouble to some machinery builders is the attitude of the average machinery user on the subject of foundations and on the method of attaching machinery to foundations.

Machine frames are of two types, namely, those that have inherent rigidity and so have need of support at three points only, and those without inherent rigidity, which must be supported at intervals in order to preserve their form and maintain perfection of alignment. The average machine user attempts to confer rigidity on machines of the latter type by bolting or grouting them firmly to a foundation. Such a procedure is fatal to the satisfactory use of planers, long lathes, and other machines of that type.

The bed of such a machine should be set on a good foundation, but should never, under any circumstances, be bolted or grouted to that foundation. Instead, it should be supported on suitable wedges or other leveling devices at intervals of from three to five feet. Many shop men, without stopping to analyze the conditions, assume that a foundation will remain true, and that if a machine bed without inherent rigidity be grouted to the foundation, it will add to the stiffness and strength of the bed and eliminate vibration.

As a matter of fact, foundations sometimes settle from 1/4 to 1/2 inch, and the writer has known of planer beds that were forcibly sprung over 1/4 inch by being grouted firmly to a foundation that had settled. As a result, the ways were no longer straight, the table vees touched only at the high spots, and the bearing surfaces were soon destroyed. If this machine had been set on leveling blocks, placed at about four-foot intervals, and the leveling blocks had been drawn up as often as necessary to compensate for the settling of the foundation, the planer would have remained accurate and the bearing surfaces perfect for the life of the machine.

Different Types of Machine Foundations

This brings up the question of machine foundations in general. Machine foundations may be divided into rock-supported foundations, pile-supported foundations, and floating foundations. Rock-supported foundations are concrete or masonry structures which rest on rock or hard clay of such bearing power that the foundation does not settle measurably under the load of the machinery. Such a foundation may be in one piece or it may be a series of piers. If a foundation of this kind is obtainable at a reasonable cost, it is the best sort of machine foundation, but even a rock-supported foundation is subject to some seasonal movement, and long beds or frames must not be grouted or bolted to it.

When the foundation, because of the cost or for other reasons, cannot be carried down to the rock, it may be laid upon piles, columns, or beams that are rock-supported. Such a foundation is less subject to seasonal movement, but is more likely to settle at points where it carries concentrated loads.

A floating foundation is one laid on an ordinary earth surface which has been properly leveled and compacted. The foundation must be stiff enough so that it transmits the weight equally to all parts of the surface, and large enough so that the distributed load does not exceed the safe bearing strength of the earth. It is usually in the form of a properly designed reinforced concrete slab.

Many people mistakenly imagine that the supporting power of a floating foundation is proportional to its depth, and spend money unnecessarily for excavation and concrete, or worse yet, erect machinery on floating piers. Obviously even a good floating foundation may settle, and provision must be made for keeping the machinery level. If the foundation carries only fixed weights, it can support a number of machines with only slight seasonal changes and very little settling. If, however, the loading varies from time to time, as, for instance, if the slab supports a column supporting a traveling crane, independent slabs should be provided for machines without inherent rigidity, while a common slab will do for a number of machines whose frames have inherent rigidity.

When a floating foundation is laid near a pile or rock-supported foundation, many masons think that they add to the rigidity and supporting power of the floating foundation by anchoring it at this point to the pile or rock-supported foundation. As a matter of fact, the foundation is then not so good as it would be if it were free from such support, for if the earth settles ever so slightly, the foundation will

no longer be true, while if the rock foundation be subject to moving loads, the floating slab will continually vary in its level.

Civil engineers have given a great deal of study to the subject of foundations, and practically all civil engineering structures are properly supported, but machinery users, instead of designing their foundations in accordance with the principles developed by civil engineers usually design them by guesswork.

The Problem of Bearing Design

The bearing is a machine element that has long been in use. Because of the great number of bearings in use, their importance, and their apparently erratic behavior, bearing design has received much thought; yet almost every user of machinery has had considerable experience with bearing troubles, and a great deal of misinformation and many false impressions are current with regard to the design and use of bearings.

The best bearing, when it is posssible to use it, is a perfectly cylindrical shaft or pin revolving in a cylindrical hole, the hole being larger than the shaft by a sufficient amount to give an oil film of proper thickness. One of the things that is often done wrong is to "scrape in" or "fit" a bearing. "Scraping in" is the old-fashioned mechanical method of making a hole the same size as the shaft. Therefore, a bearing that has been "scraped in" has no room between the shaft and box for an oil film. Such a bearing invariably runs hot until it has been "run in"—that is, until the box has been worn sufficiently large, or the shaft sufficiently small, to allow for an oil film. Since such a bearing does not usually wear to the proper form in running in, it wears too much, and becomes loose. The designer attempts to remedy one mistake by another, and divides his bearing so as to form two half-boxes, providing shims which may be removed for closing in as the bearing wears. Half-boxes are often necessary in order to assemble the bearing, but in such a case, the two half-boxes should be machined to a perfect cylindrical hole, and no shims should be used.

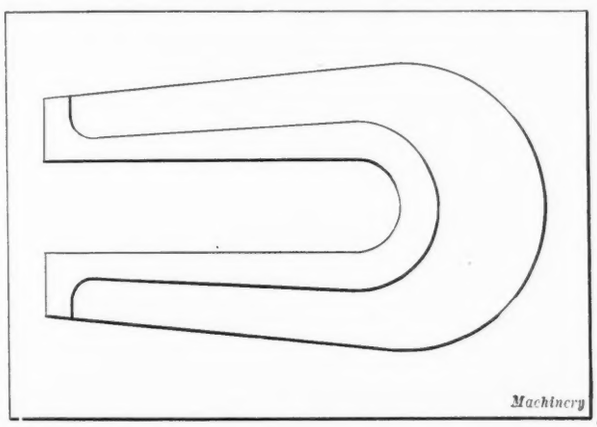


Fig. 2. Conventional but Erroneous Design of Press Frame

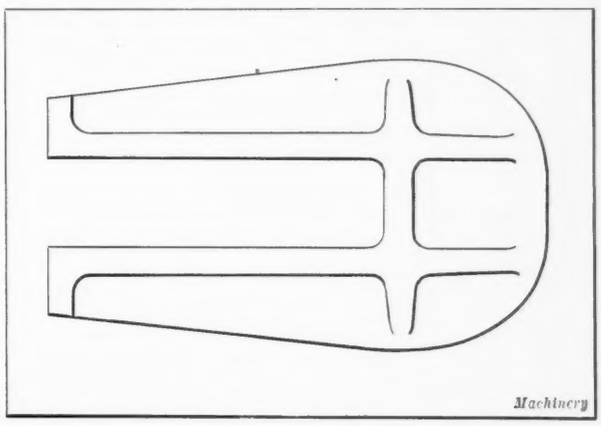


Fig. 3. Design in which Stresses are correctly distributed

The Quarter-box Bearing

While a half-box may be necessary for reasons of assembly, a quarter-box is a mechanical crime. The purpose of a quarter-box may be to provide means for taking up the wear of the bearing, or it may be to provide adjustment by which the shaft may be aligned. However, it is just as easy to provide adjustment for a whole box or a half-box as it is for a quarter-box. Quarter-boxes wear rapidly, because they cannot possibly be lubricated. The load either comes on one of the quarters, which gives an angle of only 90 degrees for support, or else it comes on two quarters and rapidly wears down the point of division between the parts of the box. The cracks at the points of division permit the oil to escape and prevent the proper establishment of the oil film. In addition to being mechanically incorrect, a quarter-box is a very expensive form of bearing, and any designer will find that if he substitutes a properly designed half-box he will eliminate a great deal of his bearing trouble.

The Lubrication of Bearings and Bearing Materials

Properly designed bearings which have an abundant and continuous supply of clean lubricating oil will show no signs of wear, unless they are required to function under extreme variations in speed. If lubrication is imperfect, or the design of the bearing is such as to produce local distortion, or the bearing operates over an extreme range of speeds, wear may occur. Wear usually takes the form of a cutting or scoring of the bearing surfaces. This may be prevented by making the two rubbing materials of sufficiently dissimilar hardness so that the softest crystals in the harder material are harder than the hardest crystals in the soft material, and then giving the hard material a sufficiently true and smooth surface.

The author is aware that this is contrary to the accepted theory of bearing metals, which requires that a bearing metal shall consist of a certain proportion of hard crystals embedded in a soft matrix. However, there is no theoretical reason for regarding a bearing metal of that type as satisfactory, except in comparison with materials that are obviously unfitted to serve as bearing metals. It is obvious that a box and shaft meeting the specifications that the author has outlined above cannot cut and therefore cannot wear. It only remains to proportion the bearing area and choose the lubricant and clearance with due regard to the speed, so that the oil pressure shall at no point exceed the compression elastic limit of the soft material.

The author cannot discuss, in the present article, the theory of lubrication of a cylindrical bearing, or the proper design and function of oil-grooving. It must be said, however, that the figure eights, criss-crosses, and complicated systems of reversed spirals with which many bearings are provided show that their designers are woefully ignorant on these points.

There is one type of bearing concerning which we have no satisfactory theory of lubrication—namely, the oscillating bearing where the external forces do not periodically reverse, or at least relieve themselves. Without such a theory we are obliged to grope in the dark in designing a bearing of this type, but that is no excuse for adopting the same procedure with other types of bearing where the light is available.

Lathe Spindle Bearings

In certain types of bearings, as, for instance, lathe spindle bearings, the conditions of service are such as to preclude perfect lubrication at certain times. At the same time, it is necessary to maintain correct alignment in spite of wear. Such bearings are often made slightly conical and provided with endwise adjustment to compensate for wear. However, the materials are usually so chosen that it is the box and not the spindle that wears, and since the wear is usually concentrated along one side of the box, alignment is not

maintained. If the usual design were reversed and the box made of hardened steel, while the revolving element were made of a suitable softer material, the wear would be distributed around the entire circumference, and correct alignment would always be maintained.

Lathe Feed Mechanisms

Many design errors have the sanction of high engineering authority. An example is the case of the feed mechanisms of lathes, which are frequently over-powered as a result of Mr. Taylor's dictum that the feed mechanism should be capable of developing the same pressure at the tool point as the driving mechanism. The only excuse for this is that in case a tool loses its edge, the feeding pressure on the tool *may* equal the cutting pressure, and the feed gearing will break if it is not proportioned by the rule mentioned. It is equally true that if certain commonly used tool forms lose their cutting edge, the feeding pressure may equal ten times the cutting pressure, and the feed gearing will break even if proportioned by this rule. The obvious remedy is to proportion the feed mechanism with an ample factor of safety against all reasonable conditions, and then to protect it by a reliable slipping clutch, or other safety device.

Frames for Punches and Shears

Another case of a design error hallowed by long and honorable engineering associations, is the G-frame for punches and similar machines. Thousands of innocent engineering students have been taught to design such a frame as a straight beam subject to combined bending and tension. Professors of mathematics have grown gray-headed and round-shouldered trying to figure out how a stress that can exist only along a straight line, can also bend around a half circle. The answer is that it does not, and the G-frame is a mechanical monstrosity.

Were a civil engineer to design a cast-iron or cast-steel structure to act in the same manner as a G-frame, he would not build a structure like Fig. 2, but one like Fig. 3. In Fig. 3, metal is provided to take care of the stresses that actually occur in the structure, the tensions in the flanges being gradually distributed as shears to the web, while in Fig. 2, the stresses in the flange, and between the flange and web, are greatly intensified where the flange is curved.

In mentioning these examples, the author has not had in mind the idea that these are the particular engineering and design errors that most require correction. He rather wishes to point out the fact that a great many people who are unable to think intelligently about engineering problems, are continually influencing engineering work, as customers for and users of engineering products, and that in the main this influence is very unfortunate. He has also endeavored to point out that engineers themselves sometimes fall into slipshod methods in their work, accepting without question time-worn errors.

* * *

GRANTING CREDITS TO MACHINERY BUYERS ABROAD

In a comprehensive review on the granting of credits when selling machinery abroad, W. H. Rastall, chief of the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce, points out that probably 75 per cent of the machinery sold in the international market is paid for promptly without request for extended credit arrangements, but inasmuch as there remains an important volume to be sold on credit it would seem desirable for the American manufacturer to adopt a flexible policy in this connection and to arrange for credit terms at times when this can be done on a businesslike basis.

However, the manufacturer should be on his guard against adopting this policy to meet what may be termed "abnormal" competition. For example, in 1924, most German manufacturers were heavily stocked with machinery that had been made while the mark was depreciating, produced at perhaps 25 per cent of what it would have cost to build it in America. Later, following the stabilization of German currency and the inauguration of the Dawes plan, these manufacturers found themselves short of working capital. They could afford to sell this machinery at very low prices and on any terms that would convert it into liquid funds. The result was that reports were received from all over the world of transactions involving prices that appeared ridiculous and terms that seemed absurd.

Result of British Trade Facilities Act

England also furnishes a case in point. Following the armistice, there was great unemployment, and in order to hasten the recovery of business, the British adopted the so-called "Trade Facilities Act," which made it possible for manufacturers to secure Government guaranteed loans, and a few instances are on record where machinery was exported to Poland and India on credit which these loans made it possible to grant, and with the terms supported by Government guaranty.

Experience under the above act, by the way, provides an interesting opportunity to estimate the importance of credit transactions in connection with machinery exports. During approximately three years of operation, it appears that the facilities of this act have been employed in connection with export machinery transactions in only three or four instances. One of these was for a large volume of textile machinery shipped to Poland, and another was for hydro-electric equipment shipped to Bombay.

In this connection, it should also be remembered that foreigners extending very liberal credits are not necessarily more successful in their export business than American manufacturers that content themselves with a more conservative policy. All over the world are instances where machinery has been sold on credit, only to develop complications in connection with collections. In China, Poland, Rumania, Spain, and India there are outstanding examples of such experiences. Clearly, it is desirable that manufacturers refuse to sell on credit unless they can discover methods that will make it possible to handle such business safely. On the other hand, it would promote American interests in the face of the world-wide competition if methods could be discovered making such credits possible.

Credits on Certain Machinery Transactions Necessary

It is undoubtedly true that by extending credits, particularly in certain countries, a largely increased volume of export business can be secured, and there are reasons why machinery purchasers in these countries wish to buy on credit.

For example, in Brazil there is a great need for capital if industry is to be developed. As yet no business processes have been developed there to take care of the financing of industry through long-time industrial loans in foreign countries, and there are no means for raising capital through investment securities in the local market. Consequently, industrialists in Brazil find it necessary to raise all their own capital or else arrange to finance themselves through their suppliers. Where a manufacturer in the United States would raise capital for any industry by the sale of mortgage bonds, a manufacturer in Brazil must plan to reach the same end by pushing the burden on to the machinery dealer. Otherwise expressed, the demand from Brazil and certain other countries for long-time credits in connection with machinery transactions represents a demand on the part of the industrialist that the manufacturers shall participate in his business to the extent of the investment represented by the deferred payments on the machinery contract.

* * *

The comparative safety of commercial aviation may be judged from the fact that in one year the Imperial Airways, Ltd., a British commercial air transport organization, made 4328 flights with only one fatal accident.

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, November 16

In so large a field as that covered by the metal-working industry, a general recovery from a prolonged period of depression must necessarily be a slow process. However, the optimism regarding trade prospects is maintained, and undeniable improvements are to be noted in many sections of the engineering industry.

The Machine Tool Industry

The machine tool industry continues to show a progressive tendency, and since the Olympia machine tool exhibition in the autumn of last year, the general position has been considerably improved. In the Birmingham area, most machine tool works are very well employed, and in several cases a full night shift is in operation in the machining departments. Even in the case of firms not so well placed, the average output is now 60 per cent of pre-war capacity. For more than two years, the principal demand in this area has been for turret lathes and screw machines and the activity in this direction is fully maintained.

Standard type drilling machines of all sizes find a good market, and there is no dearth of orders for special multiple-spindle drilling machines and simple three-operation automatics. For highly specialized machine tools, the demand remains unabated. Inquiry for such machines is by no means confined to the automobile industry, although the latter is responsible for the unprecedented demand for gear-cutting work. Gear-cutting firms are finding the greatest difficulty in obtaining sufficient gear-cutting machines. Plain and spiral bevel gear generators are in most urgent demand, and even second-hand machines of this type are difficult to obtain. For the best class of machine tools, supply is now more or less parallel with demand, and although there are still many second-hand machines on the market and business in these is comparatively brisk, the proportion of buyers whose requirements can be met from this source is becoming very limited.

The Birmingham area naturally looks to the automobile industry for a continuation of the present demand, but some very successful business has been passing for some time now for European destinations, France being an especially good customer. Machine tool works specializing on equipment for rolling stock builders and constructional engineers are very busy, while for drop-forging equipment and power presses the demand is increasing in a very gratifying manner.

In the Yorkshire area, the railways are responsible for much activity in the machine tool shops, and axle-turning lathes, wheel lathes, shafting lathes, and planers, are very prominent among the orders going through. For hydraulic tools and forging machines, the demand is not so good, but makers of surface grinding machines are working at nearly full capacity. Sheet-metal working machinery makers are working over-time, and the rapidly growing demand for steel window frames is reflected in the demand for suitable punching machines, power presses, and dies.

In the Lancashire area, business in the machine tool line is improving noticeably. There is a good demand for bar automatics and horizontal drilling and boring machines.

Overseas Trade in Machine Tools

During September the tonnage of exported machine tools fell from 1051 for August, to 829; the value also fell from £131,900 in August to £90,565 in September. Imports also showed a decided falling off in both tonnage and value, 495 tons for August falling to 368 in September, the corresponding values being £72,359 and £49,078.

The analyzed returns of exports of machine tools during August show that Great Britain's best customer during that month was India, whose purchases amounted to about £35,000 in value; Australia was next with £21,000, of which over £13,000 represented drilling machines. The Argentine followed with £10,000, Africa and Russia with about £8000 each, while of the remainder New Zealand, France, and Japan took tools to the value of about £5000 each during the month.

America sent us by far the greatest value in machine tools during August, the value being £50,000; Germany was a poor second with £12,000.

General Engineering Field

In the engineering field, conditions in the various branches show even greater contrasts than a few months ago. There appears to be a slackening off in the activity of makers of heavy electrical equipment. On the other hand, constructional engineers, locomotive builders, boiler makers, and pump makers, all of whom have experienced some very slack periods during the last two years, are increasingly active, and the immediate future promises well.

The textile machinery industry is now in a very satisfactory condition. European markets are good, and manufacturers of grinding machines are particularly busy. A large builder of hydraulic equipment has a good deal of press work in hand for a government department, and generally this branch of engineering is much better off for work.

Among other sections of the engineering field, manufacturers of brick-making machinery, wire rope makers, and boiler house equipment builders, are actively employed. Transmission engineers, though not working up to capacity, are fairly well employed.

The Automobile Industry

The outlook in automobile trade is undoubtedly of the brightest. There is no doubt that Coventry and Birmingham, as the centers of British automobile production, have done extremely well, and after the experience of the Olympia show, can look forward to a year of remarkable activity. A feature of the exhibition was the insistent demand for British made cars from the dominions and many foreign countries. Automobile manufacturers are busy preparing for production on a more lavish scale, and are active buyers of machine tools. At the moment, the average rate of output in the more popular types of automobiles is about 80 per cent of full capacity, and arrangements are being made to increase full capacity by, roughly, 20 per cent.

The cycle industry has just concluded the most successful season in its history, and factories are once again getting into stride on next season's programs, which will be bigger than ever.

The exhibition of commercial motors now being held at Olympia has added importance this year in the absence of a corresponding Paris show. The most striking feature of the show is, perhaps, the diversity of the applications of motor transport, ranging as they do from the lightest tradesmen's delivery vans to road coaches of Pullman character that have superseded the ordinary motor char-a-banc, and six-wheeled mounted trucks, combining the very high carrying capacity with the best possible distribution of weight over several wheels. The use of pneumatic and semi-pneumatic tires on fairly heavy vehicles is another development evidenced in the exhibition.

Current Editorial Comment

in the Machine-building and Kindred Industries

HAND-TO-MOUTH BUYING INCREASES THE COST OF SMALL TOOLS

A new buying policy for tools and supplies has been adopted recently by many of the large machinery manufacturers, who years ago frequently bought in one order enough to cover three or four months' requirements. Now, many buy only a month's supply at a time—sometimes less. This policy has created a new and difficult problem for the small tool manufacturers.

Many orders require delivery within ten days or two weeks, and this makes it necessary for manufacturers to carry on hand a large stock of all standard tools, so that orders can be filled promptly. Sufficient equipment and a large number of men must be available also at all times to take care of rush orders for special tools. Much of this equipment stands idle a large part of the time, because the work in the plant fluctuates to such an extent that there may be but four or five days' work for a full force one week, while the next week a large number of men must work overtime, or a night force must be put on.

According to one manufacturer, if the buyers of tools could adjust themselves to a stock product within reasonable limitations as to size, etc., the situation could be worked out economically; but as nearly 50 per cent of the tools ordered usually are of a special type that must be made to order, the problem is a difficult and expensive one. The practice of hand-to-mouth buying increases the cost of small tools and supplies, and this increase must ultimately fall on the consumer.

Buyers of such supplies can usually estimate their requirements for three to four months ahead; and if they do not wish their orders delivered all at one time, can so arrange that manufacturers can adjust their production to avoid the waste of running their shops far below capacity one week, and far beyond, the next week. We are all working for economies, direct and indirect; and perhaps you can help in this.

* * *

KEEP RECORDS OF BREAKDOWNS

The real value of one machine as compared with another cannot be ascertained unless actual records are kept of its performance in the shop. Too frequently machines are praised or condemned because of mere opinions on the part of a superintendent or foreman. Two machines of entirely different design, performing the same kind of work in a forge shop, recently were compared by the superintendent who objected strongly to one type because of frequent breakdowns. He said they had trouble with that type of machine once or twice a week, while the other type ran for months without difficulty. On the strength of this opinion, he decided against buying more equipment of the type that he considered defective.

Actual records would have shown, however, that in the machine that required frequent repairs—unavoidable because of its character—repairs could be made in one or two hours, and the loss of time did not average more than ten or twelve hours a month. The other type of machine would run steadily for two or three months, but when it needed attention and repairs, it required a complete overhauling so that its production was suspended for a week or more. Figures showed that the actual loss of time, in hours, on the machine that gave frequent trouble was not more than one-half that of the other machine. This is not a defense of the machine that broke down frequently, but an example showing that facts and figures are the safest guides in judging machinery.

* * *

TOO MUCH SYSTEM

The installation of systems of various kinds in our machine-building plants during the past twenty years has greatly increased their overhead costs. Some systems have justified their costs; many have not, for the keeping of records and the filing of data can be overdone.

In a plant recently visited that twenty years ago employed 300 men, the force now numbers about 450. When the smaller number was employed, the superintendent's office force consisted of one designer, one draftsman, one cost clerk, and one "order chaser." Today the same plant, with a 50 per cent increase in its productive working force, employs half a dozen designers and draftsmen, a cost keeping department with nearly a dozen people, and an "order chasing department" almost as large. There is now also an assistant superintendent, and the cost of the shop superintendent's office is seven times what it was twenty years ago, while the value of the shop's product is about two and one-half times as great.

These organizations often grow, when once started, to proportions that absorb far too much of the profits, and in many cases a careful examination of the purpose and usefulness of those comprising them would enable manufacturers to effect material savings, without impairing the efficiency of their business.

* * *

WE STILL NEED STANDARDIZATION

So much has been written and said about standardization that, on the surface, very few new ideas apparently can be advanced about this subject. Yet many mechanical men do not realize how utterly "unstandardized" our mechanical industries are.

The records of a manufacturer of taps and dies show that his customers required to have made a total of 55,000 different kinds of taps, dies and chasers. A study of these records show that nearly two-thirds of the demand is for only 500 sizes and types, which may be considered the standard sizes. Two thousand different varieties cover 80 per cent of the output of the plant. Probably some of these would have to be included as standard sizes, but still there remain 53,000 types and sizes, constituting only 20 per cent of the total output of the plant, that must be classified as entirely special. If the details could be carefully examined in each case, it doubtless would be found that standard sizes could have been substituted for many of these special types without serious inconvenience to the user.

It is wasteful for the industry as a whole to require 55,000 different types and sizes to be made, when probably 1000 standardized tools would do. The industries that use these tools pay for this lack of standardization. It costs more to make special tools to order than to keep standard tools in stock. Just how many million dollars a year the mechanical industries waste through their lack of standardization it is impossible to compute. The automobile industry is said to have saved $750,000,000 a year through its standardization of important parts entering into the building of cars. All these figures show that we still need standardization.

Dies for Steering-wheel Spiders

Construction of Dies Used in Stamping a Hub for Steel Spiders of Automobile Steering Wheels
First of Two Articles

By JAMES M. ACKLIN, Vice-President and General Manager, Acklin Stamping Co., Toledo, Ohio

STEEL stampings are used for making automobile steering-wheel spiders that are unbreakable in case of an accident, even though they are badly bent. As may be seen in Figs. 1 and 7, these spiders have four arms *A*, made from steel 0.050 inch thick, which are clinched to a hub *B* produced from steel 0.093 inch thick. Into this hub is cast an alloy of aluminum, copper, and zinc, as illustrated at *C*, to form a rigid bearing for the steering rod and to provide an additional anchor for the arms. The cored hole of the cast material is reamed and broached to receive a key, and the top of the material is faced for the sake of appearance. A wooden rim *D*, 16 inches in diameter, is finally attached to the arms.

These steering-wheel spiders are made in large quantities at the plant of the Acklin Stamping Co., Toledo, Ohio, by the use of power press dies for forming the hub and arms and for assembling them together. Interesting points concerning the dies used in producing the hub will be described in this article, while a second article will deal with the dies used in producing the arms and in assembling them to the hub. The second article will also describe a continuous type of machine employed for casting the alloy hub center. All the press work is performed in single-action presses. There are fourteen press set-ups, but with some operations running faster than others, a different press is not required for each operation. With ten to twelve presses and the equipment described, a daily production of thirty-five hundred spiders is averaged.

Producing the Hub

The hub stamping is produced from an eight-sided blank, as shown at the left in Fig. 4, which saves considerable material, compared with what would be required if a round blank were used. The blank is cut by means of the punch shown at the right in the same illustration. This punch is used as shown at *A* in the combination blanking and drawing die illustrated in Fig. 2, cutting the blank as it enters die ring *B*. On the continued downward stroke of the press ram, the punch draws the blank on the plug *C* to the shape indicated by the heavy solid line, against the pressure exerted by a spring or rubber buffer through pins that come in contact with the lower side of ring *D*. During the return stroke of the ram, the piece is stripped from the die as ring *D* is returned to the raised portion, but if it adheres to the punch, it is dislodged by knock-out pad *E*. Two guide posts hold the punch and die parts in alignment. In this and succeeding dies to be described, the cutting, forming and stripping members are made of carbon tool steel, and other parts of machine steel. The upper part of die ring *B* is a piece of tool steel, and is welded to a machine-steel base.

Next, three redrawing operations are performed in sets of dies that are identical in design and size, except for the actual working parts. With this arrangement, should a punch-holder or die-shoe break, the redrawing tools can be readily substituted in the punch-holder and die-shoe of another press until the broken part is replaced. In the first of these redrawing operations, the shell is drawn to the outline illustrated at *X*, Fig. 3, and in the third, to the shape shown at *Y*.

In each operation, punch *A* draws the piece on plug *B* during the descent of the press ram, against the pressure exerted by ring *C*. This ring, as in the preceding example, is held firmly in contact with the flange of the work by the action of a

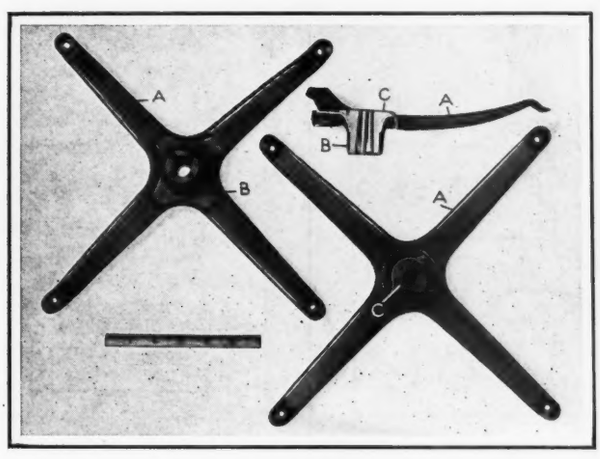


Fig. 1. Automobile Steering-wheel Spider made of Steel Stampings

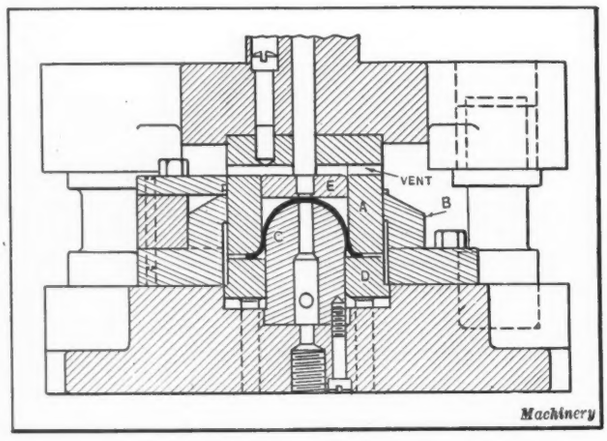


Fig. 2. Combination Blanking and Drawing Die used in the First Operation on the Hub

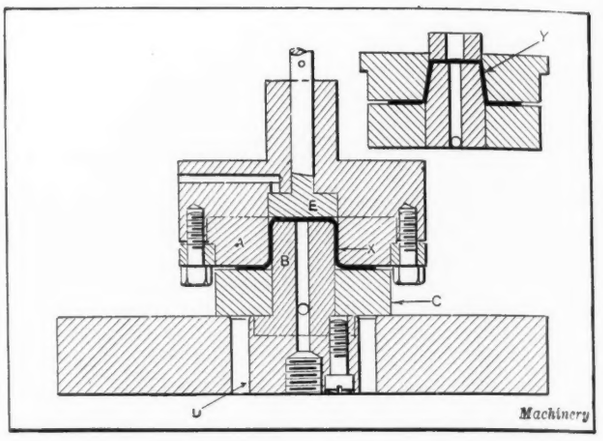


Fig. 3. General Design of Die employed for Three Redrawing Operations

spring or rubber buffer that forces up pins operating in holes *D* in the die-shoe. Again, ring *C* strips the work from the die, and knock-out pad *E* ejects it from the punch.

Trimming and Edging Dies

In the next operation on the hub, the flange is trimmed to the irregular outline shown at *X*, Fig. 5. The punch is equipped with a spring-actuated pad *A* which enters the work ahead of the shearing member *B* and centers the work properly. The trimming is accomplished as punch *B* passes the upper edge of the die ring *C*, and the resulting scrap stock is cut in half by several cutters *D*. After the flange is sheared, the work drops through the die ring *C* and the bed of the press into a receptacle, the absence of an obstructing die part permitting a substantial reduction in the time of the operation. Guide posts are also provided for this die set to maintain the alignment of the punch and die parts.

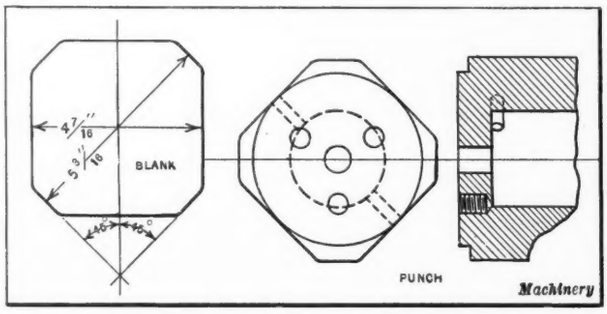


Fig. 4. Blank from which Hub is formed, and Punch used to cut it

The hub is next brought to a press equipped with the die illustrated in Fig. 6, for turning up the flange edges, as indicated by the heavy solid line. At the same time a trade-mark, patent number, etc., are stamped on the flange. The flange is turned up as punch *A* pushes the work into die ring *B* against the pressure exerted by die-block *C*, which is actuated by a rubber buffer, as in the preceding dies. As the die "bottoms," the trademark, patent number, and similar data, are pressed into the work by four hardened plugs *D* which are inserted into the face of punch *A*. This punch is also equipped with an ejector, and block *C* serves as a stripper for the die.

Cutting and Piercing Dies

A hole 1 3/8 inches in diameter is then cut through the bottom of the hub stamping by means of the die shown in Fig. 8. For this operation, the work is seated on ring *A* and located centrally by plug *B* as punch *C* descends. The end is sheared as the cutting edge of the punch passes over plug *B*. In this operation, pressure is also exerted against ring *A* and the work by a rubber buffer that operates through pins *D*, and guide posts are provided to maintain alignment between parts *B* and *C*.

The simple die shown in Fig. 9 is used to pierce four holes spaced equally around the hub. In this operation, the

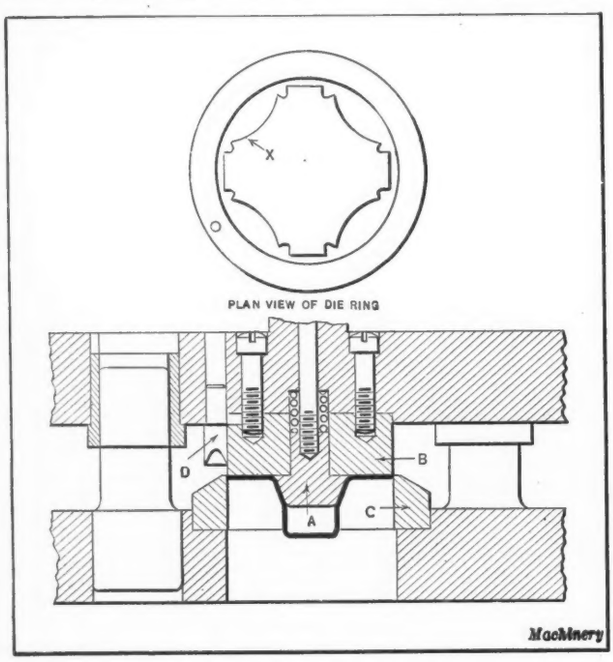


Fig. 5. Trimming Die by Means of which the Hub Flange is cut to the Outline indicated at X

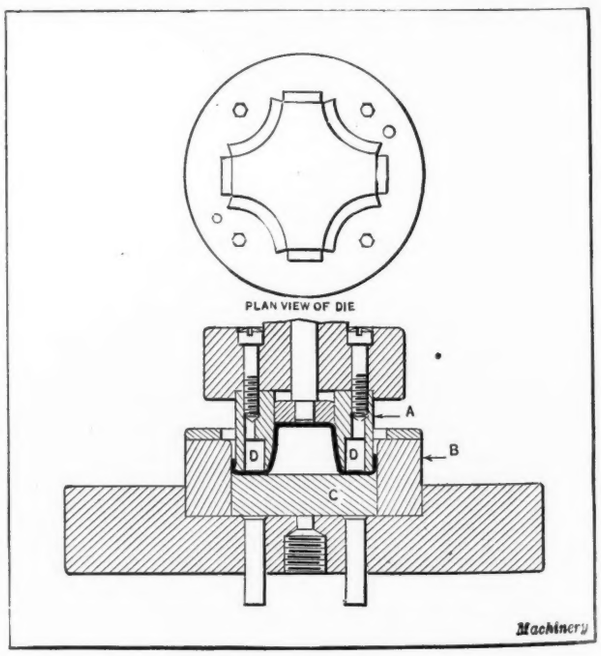


Fig. 6. Die Set used for turning up the Edges of the Flange and stamping the Trademark

work is seated on a horn *A* and located by pushing it back against a shoulder on part *B*. The latter has clearance for the punch, and strips the work from the punch on the return stroke of the press ram. After each hole is pierced, the work is removed from the horn, turned 90 degrees, and replaced for punching the next hole. This die completes the manufacture of the hub; the dies employed for producing the arms and for assembling them to the hub will be described in the next article, together with the continuous type of machine which is used for casting the alloy center in the hub.

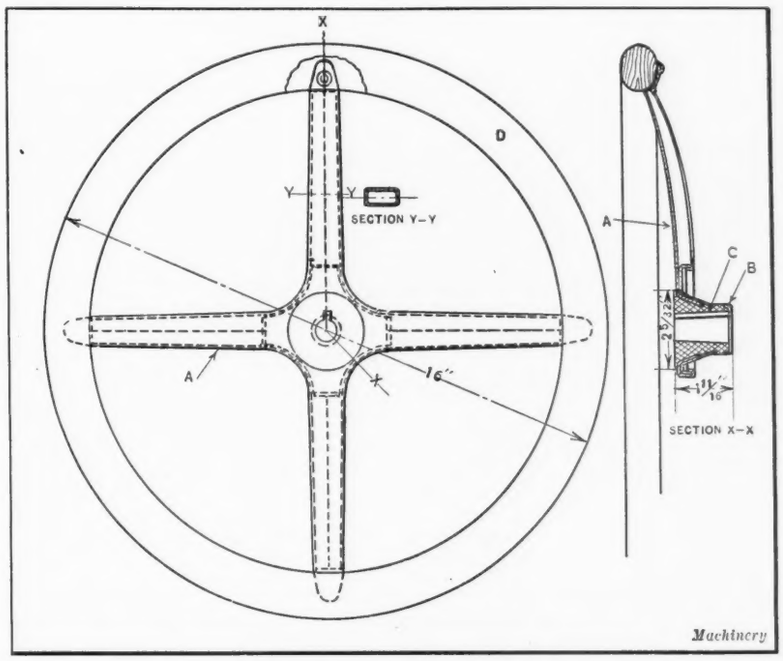


Fig. 7. Completely Assembled Automobile Steering Wheel

* * *

CORROSION IN GASOLINE ENGINES

In a paper read by Frank Jardine before the Society of Automotive Engineers, it was stated that corrosion in gasoline engines is generally believed to be due to sulphuric acid formed by the combination of sulphur carried in low-grade fuels with water entering or generated in the engine. Much of this trouble occurs in the winter time, and may be traced directly to the action of water which condenses on the inside of the cylinders when a cold motor is started. Water so formed may come into direct contact with the metal of pistons, cylinders, etc., by destroying the oil film remaining on the surfaces when the engine is stopped. If this occurs and the lubricating system does not immediately supply fresh oil to these parts, scored pistons and cylinders are likely to result, or if the engine is stopped in this condition, the water will rapidly attack the exposed metal parts, causing rust to form, which will make matters worse when the engine is next started.

The only completely successful way of dealing with the condensation problem, and consequently with the rust problem, is to provide a lubricating system that will start to function as quickly as the motor starts. The old-fashioned splash feed system has been found to meet this requirement almost perfectly. If pressure systems are used, a number of points should be given careful attention. (a) The oil pump should be located in the sump; (b) no screen finer than 20 mesh should be used over the intake; (c) oil lines should be as straight and short as possible and of not less than 1/2 inch inside diameter; (d) connecting-rods should have 0.0015 inch diametral clearance and 0.006 to 0.008 inch side clearance; (e) light oils should be used in the winter.

Road tests have not confirmed the general belief that the use of thin or diluted oils is responsible for rapid piston and cylinder wear. A castor oil film has been found to be much more resistant to the destructive action of water than a mineral oil film, and it may be found advantageous to coat with castor oil the inside of finished engines that are to be stored for any considerable length of time in cold weather.

* * *

RUSSIA BUYS MACHINERY

A synopsis of the official report of a delegation of the textile industry of Soviet Russia, recently made public, indicates that orders were placed by the delegation for textile machinery valued at $8,750,000 in England, and for equipment worth $1,550,000 in Germany. It is stated by the Russian Information Bureau, 2819 Connecticut Ave., N.W., Washington, D. C., that the terms generally were as follows: 10 per cent cash with the order; 20 per cent during a four-month period following the placing of the order; 20 per cent upon the shipment of equipment; and 50 per cent distributed in payments extending through a period of twenty months.

* * *

According to data collected by the United States Census Bureau, the investment of capital per worker in the industries in the United States is approximately $4900. On the average, somebody has to provide one half million dollars to invest in buildings and machinery before 100 people can be employed in the industries.

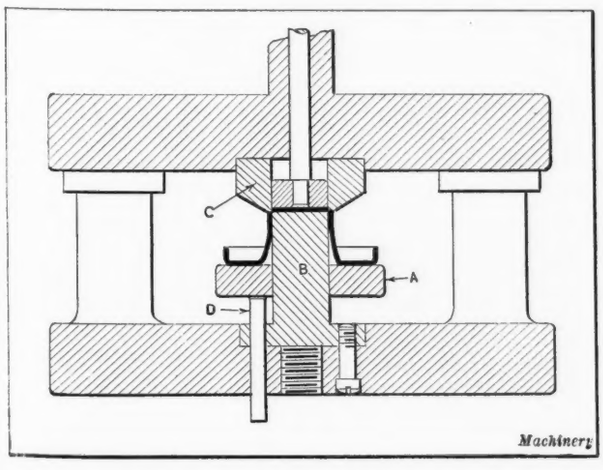


Fig. 8. Die for punching a Large Hole in Projecting End of Hub

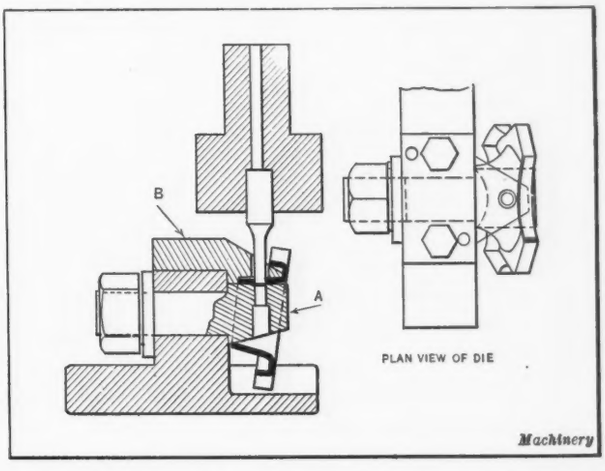


Fig. 9. Die for piercing Four Anchorage Holes around the Hub Proper

Measuring High Speed by Sound Vibrations

By C. R. ALDEN Research Engineer, Ex-Cell-O Tool & Mfg. Co., Detroit, Mich.

DEVELOPMENT of devices for producing high rotational speeds and the equipment for accurately measuring these speeds seems to have been left to the makers of internal grinding spindles, and the reason for this is apparent when it is remembered that the proper peripheral cutting speed for a small grinding wheel of approximately 5/64 inch diameter can only be attained at rotational speeds in excess of 50,000 revolutions per minute. Such speeds are readily developed by means of small air-turbine driven spindles mounted on specially designed ball bearings, such as were described in the May, 1925, number of MACHINERY (see page 741). Owing to the small power output required for these turbines, none of the commonly used tachometers are suitable for measuring this speed, as the mechanical load imposed by the speed-measuring device reduces the turbine speed so that the reading is valueless. Another requirement of such a device is that it should be possible to measure the speed of a spindle without removing it from the grinding machine, and if it should be desired, to take speed readings while the spindle is performing its regular duties.

The inventor of the device described in this article, C. R. Alden, was born in Alden Post Office, Washington County, Ohio. He obtained degrees in mechanical and electrical engineering at Ohio Northern University, and was later connected with the Westinghouse Electric & Mfg. Co. He has been Dean of the Trades and Technical Schools at Detroit Institute of Technology, and Dean of the College of Engineering, Ohio Northern University. He is now engineer and sales manager for the Ex-Cell-O Tool and Manufacturing Company.

The device to be described is arranged so that the pitch of the sound emitted by a high-speed spindle is compared with the sound or note emitted by the speed-measuring device; the latter is so calibrated that it indicates directly the revolutions per minute corresponding to a given note in the musical scale, which, in turn, is equivalent to a certain number of vibrations per second. A simple diagram will be used first to illustrate the fundamental principle.

If the spindle can be caused to drive a small bipolar alternating-current generator, the rotor of which is mounted directly on the turbine shaft, the frequency of the alternations will, of course, be governed by the speed of the turbine, each revolution of which will be responsible for a complete cycle of the alternating current generated. The effect of each cycle of this alternating current, if allowed to flow through the coils of an ordinary telephone receiver, will result in one complete vibration of the diaphragm, both of these relations being graphically shown in Fig. 2. The generator armature core of laminated iron is represented at *C*; the generator coil at *D*; the telephone receiver magnet and coils at *E*.

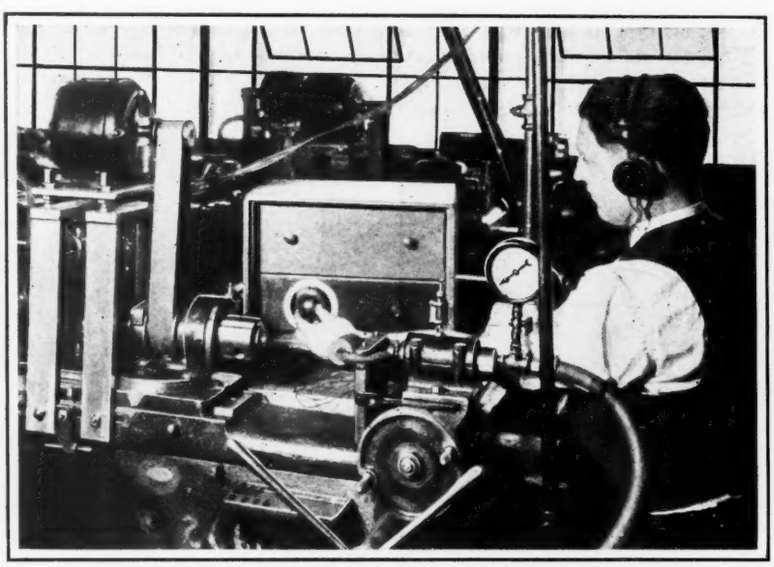


Fig. 1. High-speed Measuring Device applied to an Air-driven Grinding Spindle

It will be seen that the diaphragm of the telephone receiver changes from position *A* to position *B* in one-half cycle of current flow, and returns to its original position during the next half cycle, thus making one complete vibration per cycle of alternating current generated. The position of the diaphragm when the rotor is in position 2 is indicated at *A*, and the position of the diaphragm when the rotor is in position 6 is indicated at *B*. The central position relative to *A* and *B* corresponds to rotor positions 4 and 8.

It is well known that the musical note known as middle C, international pitch in the musical scale, is produced by 261 vibrations per second. This note, therefore, would be generated by rotating the magnetized rotor of the device referred to 261 revolutions per second, or 15,660 revolutions per minute. Such a speed is indicated when the note emitted from the receiver corresponds in pitch to that emitted by a tuning fork or musical instrument pitched to middle C.

The accompanying table expresses the note emitted by a rotating body (which sets up one complete vibration per revolution) in revolutions per minute; it is based on international pitch middle C at 261 vibrations per second. A bipolar alternating-current generator, when connected to a telephone receiver, will emit the same note at a given speed as that given by the mechanical vibrations of a body. If the note emitted by the receiver were pitched one octave above middle C, the number of its vibrations would necessarily be twice that of middle C or 522 vibrations per second, indicating a speed of 31,320 revolutions per minute. With this as a starting point, a table may be calculated for each of the twelve notes in terms of the revolutions per minute indicated thereby, as shown.

Early in the study of this problem it was noted that the same pitch emitted from the telephone receiver may be heard anywhere in the vicinity of the device undergoing test, whether or not the generator represented in Fig. 2 is mounted on the device. Such a result might have been anticipated, as it is a practical impossibility to balance the rotating element of a device of this

kind so carefully as to eliminate entirely mechanical vibration. It will be readily appreciated that each revolution results in one vibration and that the vibrations at high speeds will result in an audible musical note which may be compared with a musical note of known pitch, permitting the speed to be read directly from the table without the use of the generator and telephone receiver shown in Fig. 2.

The method of speed counting as outlined up to this point is correct as to theory, but the practical difficulties of having to use a set of twelve tuning forks or a musical instrument are apparent, as well as the difficulties involved in interpolating the speed reading when the pitch set up by the speed to be measured lies between the pitch of two tuning forks. These difficulties may be overcome by the application of the modern vacuum tube now familiar to all through its use in connection with radio reception.

Arrangement of High-speed Measuring Apparatus

A circuit similar to that represented in the diagram Fig. 3 is used, in which oscillations lying within the desired range of audio frequency and variable at will may be generated. This is accomplished by the use of a fixed condenser and a variable inductance. In the diagram, the fixed condenser is represented at *C*, and *D* is the handle for moving the core in the inductance coil. The primary and secondary windings which both surround the movable core are represented at *E*. The audio-frequency transformer is at *F; G* indicates the WD 11 vacuum tubes; *H* is the generator that is attached to the spindle under test; *J* represents the speed dial, graduated to indicate the speed in thousands of revolutions per minute; *K* is a 1 1/2 volt "A" battery; *L* is the rheostat; *M* and *N* are 45-volt "B" batteries; *P* indicates a pair of ordinary head-phones, such as used in connection with radio receivers; and *Q*, *R*, and *S* are phone jacks. As shown by the diagram, the phone at the right is connected with the oscillatory circuit of the speed measuring device, and the phone at the left is connected with the generator circuit, although, in practice, it has been found that this generator and its phone are rarely required, because the mechanical vibrations of the device under test are usually audible.

In actually measuring the speed of a spindle, handle *D* (or a revolvable dial that serves the same purpose) is adjusted until the note or pitch of the oscillatory circuit is the same as the note due to the mechanical vibrations of the spindle under test; then graduations showing the position of the adjustable member (handle *D* or an equivalent dial) indicate the speed in revolutions per minute. The movable core of the inductance will always cause oscillations of the same frequency or pitch to be generated when placed in a given position, and the entire range of available pitches may be calibrated by comparison with standard tuning forks. Interpolations between the half-note steps of the twelve

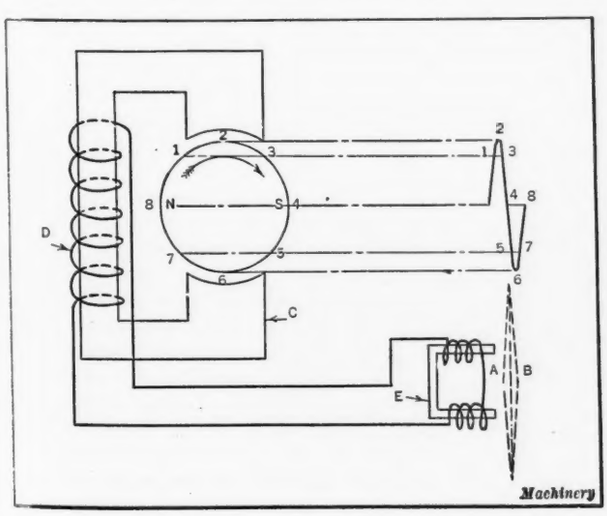


Fig. 2. Diagram illustrating Cycle of Current Flow in Coils of Telephone Receiver, generated by One Revolution of Rotor

NOTES IN MUSICAL SCALE AND REVOLUTIONS PER MINUTE CORRESPONDING TO EQUIVALENT VIBRATIONS

Notes	First Octave below Middle C	Middle C	First Octave above Middle C	Second Octave above Middle C
	Revolutions per Minute			
C	7830	15660	31320	62640
C#	8482	16964	33928	67856
D	9135	18270	36540	73080
E_b	9787	19575	39150	78300
E	10439	20879	41758	83516
F	11092	22185	44370	88740
F#	11745	23490	46980	93960
G	12397	24794	49588	99176
G#	13050	26101	52202	104404
A	13702	27405	54810	109620
B_b	14354	28709	57418	114836
B	15008	30016	60032	120064

Machinery

tuning forks may also be made, and the scale may be graduated to read directly in revolutions per minute.

The apparatus shown in Fig. 1 includes the generator mounted on the end of the spindle under test, and the phone connected with this generator, in addition to the phone for the oscillatory circuit. The dial on the panel of the speed-measuring device is used for regulating the pitch of the oscillatory circuit so that it coincides with the pitch or note emitted by the spindle under test. The pitch set up by the oscillatory circuit may be amplified for use in a loud-speaking unit instead of using head-phones. The loud-speaker may be incorporated in the speed-measuring device, making one small portable device include all the component parts for indicating speeds from about 7000 revolutions per minute up to any speed that has yet been or probably will be developed.

Below a speed of about 7000 revolutions per minute the pitch of the note emitted by the device undergoing test is difficult to distinguish. Each succeeding octave of pitch emitted by the device being tested, above that given by the calibrated oscillatory circuit, simply represents a speed which is two, four, eight, or sixteen times the reading shown by the scale on the instrument. In order that the musical octave may be distinguished more readily when the pitch of the device being tested is one or more octaves higher or lower than that of the speed-measuring device, push-buttons *A* and *B*, Fig. 3, have been provided on the face of the panel so that the note emitted by either the speed-measuring device or the device being tested (provided a phone and generator are used) may be interrupted for comparison.

Even in case the small alternating-current generator and phone are used with the device being tested, the load imposed is practically negligible, and the speed of the device is therefore not appreciably affected. The taking of the speed may be accomplished without disturbing the device being measured, and since the reading is taken by means of the sound waves emitted, the speed of the device being measured cannot be affected even to the slightest extent.

The extreme accuracy of the device described (which has been patented) will be appreciated when it is recalled that a pronounced beat note will be heard as the pitches of the two notes under comparison approach synchronism (the condition of being exactly in tune or in step). It is readily possible to detect a beat note of one vibration per second, which would represent an error of tuning of one revolution per second or 60 revolutions per minute, provided the graduated dial could be read with exact accuracy. When this error is expressed as a per cent error in the speed being measured (say 60,000 revolutions per minute), the reading may be taken with an accuracy of one-tenth of one per cent.

The limiting condition as regards accuracy would seem to be the ability to make the dial graduations fine enough to be read without error. The presence of iron in the magnetic circuit does not seem to introduce any error as far as the degree of accuracy required for use in connection with the

testing of internal grinding spindles is concerned. It will readily be seen that the use of iron in the inductance coil could be eliminated and the number of possible scale graduations greatly increased by the use of two oscillating circuits of what is now known as "radio frequency," the note to be emitted by the device being the heterodyne obtained from these two circuits.

In demonstrating this device in Cleveland at the machinery exhibit of the American Society for Steel Treating, the oscillatory circuit was connected to an ordiary radio loudspeaker instead of using the head-phones. This enabled the device to be demonstrated to quite a large crowd at one time, as the note emitted by the vibration of the spindle under test and also the note emitted by the oscillator were audible to the entire group. It was interesting to note how readily the beat note, indicating the difference in vibration between the spindle and the oscillator, could be detected. It was also interesting to notice how quickly practically

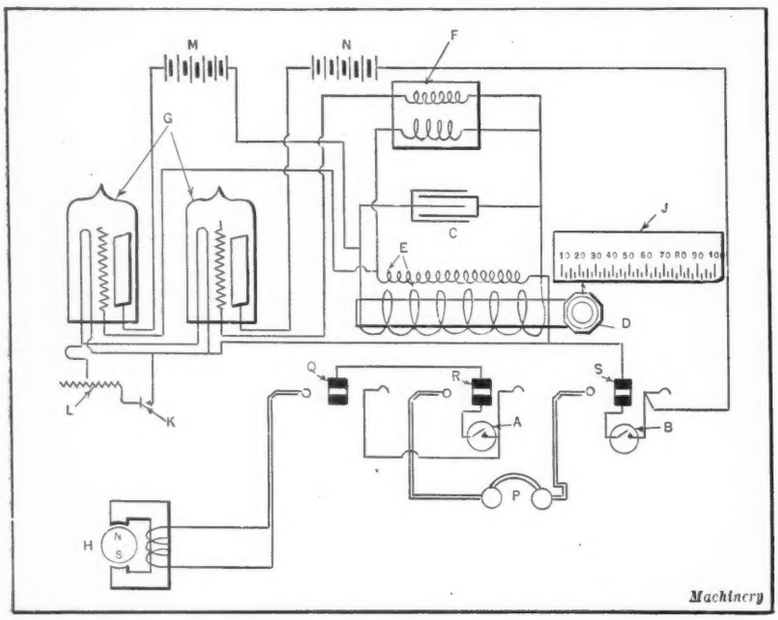


Fig. 3. Diagram of Circuit of High-speed Measuring Device—Generator and Phone ordinarily are not required, as Note due to Mechanical Vibration of Device under Test is Audible

every one who was watching the device grasped the underlying principles, especially when given a demonstration of tuning the oscillator until the beat note disappeared.

* * *

CAPACITY OF AMERICAN INDUSTRIES

A great deal has been written about the overdevelopment of our industries, says *Commerce and Finance*, and in view of that fact, a chart published by the National Industrial Conference Board, after extensive research into the production of 1923, should be of interest. The figures quoted below are compiled from this chart. In considering the meaning of these figures, it should be remembered that 1923 was a banner year in production, taking the industries of the United States as a whole. It appears, however, that in that year actual production of motor vehicles was only 75 per cent of the producing capacity of the plants. The steel works operated at an average of 75 per cent capacity, the foundries and machine shops at 70 per cent, the electric machinery industry at 78 per cent, blast furnaces at 55 per cent, the paper and wood pulp industry at 81 per cent, and the cotton industry at 63 per cent. This, however, was a very considerable gain over the production in 1921. The average production of the major industries was only 57 per cent of capacity in 1921, which rose to 72 per cent in 1923. The total value of the output of manufactured goods in the major industries in 1923 was $60,000,000,000, while the estimated maximum output is $84,000,000,000.

THE GERMAN MACHINE INDUSTRY

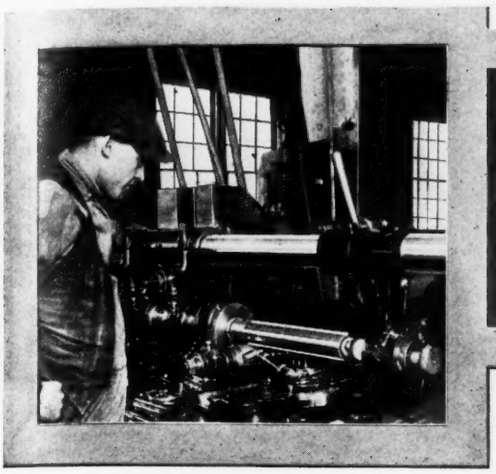
According to Commercial Attaché Herring, the German machine industry in nearly all branches continues to complain of slack business and generally unfavorable production conditions. The credit situation has not improved, and in some plants the shortage of working capital has grown more acute because of the greater conservatism of the banks since the difficulties of certain large German concerns became known. After a considerable period, during which there were no wage troubles, there have been in recent weeks many disagreements, together with a steadily upward wage tendency. Despite the current slump in the coal and steel trades, it is claimed that the cost of raw materials is too high.

The machine industries are now feeling the full effects of the war on skilled labor conditions. During the war there was an inevitable discontinuance of the apprenticeship system, which previously insured a regular and adequate supply of skilled labor for the various branches of industry. Young men under military age were offered much higher wages in munitions plants and elsewhere than the meagre apprenticeship pay. During the inflation period, the apprenticeship system further suffered by the very slight difference between the pay of skilled and unskilled workers. This unfortunate equality of pay (the difference was seldom more than 15 per cent) was at one time a cardinal principle with the labor unions, who maintained, with a good deal of justification, that the average pay of highly skilled workmen during that troubled period was scarcely more than a "minimum existence" wage, and that any wage difference sufficient to encourage common labor to qualify as skilled workers was impossible. The German Machinery Manufacturers' Association has recently called attention to this very unsatisfactory situation, which is now being gradually remedied.

Business in the machine tool industry is dull except for one or two special lines. Textile machinery producers are complaining about increased British competition in the export markets, but domestic orders have increased somewhat. Prospects seem to be good for agricultural machinery, as there is a likelihood of a record-breaking harvest. Woodworking and sawmill equipment is in small demand, and the production of heavy motors, hoisting machinery, and transportation equipment is being sharply curtailed.

The machinery industries are thoroughly dissatisfied with the long delay in negotiating and adopting commercial treaties with countries offering an important market for their products. It will be recalled that in Spain, Italy, France, the British Dominions, and elsewhere, German goods are now, or have been, subject to higher tariff duties than those from competing countries, and the machinery industries hope to increase exports materially when the existing discriminations are removed.

These industries are particularly concerned over the present status of the negotiations with Spain. The commercial treaty between Germany and Spain was ratified, but was later denounced under the clause allowing either country to retire from the agreement upon three months notice. Following the conclusion of the treaty, it was reported that heavy machinery orders had been placed in Germany but that in many cases it would be impossible to finish and deliver the goods within the three months period after denunciation. Germany's denunciation of the commercial treaty with Spain has been followed, as expected, by many cancellations by Spanish importers unable to pay the prohibitive duties now levied.



Special Work on Gear-cutting Machines

Use of Gear-cutting Machines for Drilling and Milling, and Application of Gear Generators for Special Operations

GEAR-CUTTING machines often prove efficient for operations other than cutting the teeth of gears. For instance, machines of the automatic formed-cutter type may be utilized for a variety of purposes requiring an automatic indexing movement in conjunction with some operation such as milling duplicate parts or drilling a series of holes. Work of this kind includes cutting the teeth of ratchet wheels, saws, sprockets, etc., slotting armatures, drilling equally spaced holes located on a circle, and many similar operations. Some gear-cutting machines of the generating type, such as gear-hobbing machines and gear shapers, prove very efficient for certain manufacturing and special operations, particularly when the generating principle can be applied to advantage, as, for example, in forming multiple splines or in cutting the teeth of ratchets and sprockets.

Drilling Attachment Applied to Automatic Gear-cutter

A method of converting a gear-cutter into an automatic drilling machine is illustrated in Fig. 2. The operation consists of drilling and boring twenty equally spaced holes, 7/8 inch in diameter, through lugs or bosses on a gear of special form. The machine is equipped with a special attachment for driving the drill and boring tool. This attachment is driven by a bevel gear that is carried by an arbor inserted in the regular cutter-spindle. On the attachment spindle there is another bevel gear, thus providing a right-angle drive. The end of the spindle has a standard taper hole for receiving the drill shanks. A 1/2-inch drill is used first, and this is followed by a 1 5/8-inch size; the holes are then finished accurately by using a single-point boring tool. The work is rigidly supported against the thrust of the tools by the regular support used for this purpose in cutting gears.

Another method of arranging a machine of this type for drilling operations is to mount an electric drill on the cutter-slide. An effective method of supporting the drill close to the work is by using a bushing held close to the work by an arm attached to the base of the machine.

The variety of drilling and milling operations that can be performed on automatic gear-cutting machines is very large, and, aside from the capacity of the machine, depends largely upon the construction of whatever special attachments or fixtures may be required. Fig. 3 shows how a gear-cutting machine was converted into an automatic milling machine of the "station" type. The operation is that of milling the jaws of brake-rod yokes for automobiles. A gang of three milling cutters is used, and four surfaces are milled simultaneously. These cutters are driven directly by the regular cutter-spindle. The two outer cutters are 4 1/2 inches in diameter, whereas the central cutter is 5 inches in diameter, and wide enough for milling both inner sides of the yoke. Twenty-four of the yoke forgings are held in radial positions around the rim of the fixture, which is mounted on the regular work-spindle. These yokes are equally spaced on the fixture, and the indexing mechanism is arranged the same as though a gear having twenty-four teeth were being cut.

Another method of using a gear-cutter as an automatic milling machine is shown in Fig. 4. This machine is a combination type, adapted for cutting either spur or bevel gears, and special equipment was not required for this particular operation, which is that of milling narrow slots in the disk-shaped part shown mounted on the work-spindle. As the illustration shows, the cutter carriage is adjusted to the 90-degree position for this operation. In milling similar parts requiring closely spaced slots, it is the practice to mill every alternate slot and then the intermediate ones in order to avoid distortion due to local heating.

Cutting Clutches on Gear-cutting Machines

Various forms of clutches are frequently milled on gear-cutting machines, since the operation is similar in principle to that of cutting gear teeth. Fig. 5 shows an automatic gear-cutting machine arranged for clutch milling. The clutch is first turned and then the bevel gear is cut, and finally the clutch is milled. The special holding device permits turning the clutch blank before cutting the gear or clutch teeth so that only one turning operation is necessary. These clutches each have eight teeth, and they are cut at the rate of seven per hour. The cutter is made to straddle the tooth being milled so that both sides of a tooth are formed during one passage of the cutter, instead of both sides of a tooth space. In other words, the cutting edges conform to the tooth shape instead of the space between adjacent teeth.

A rather unusual clutch-cutting operation is shown in Fig. 6, which illustrates the use of a gear shaper equipped with a special duplex type of tool. The tool-holder carries two slotting tools, located one above the other. These tools cut on opposite

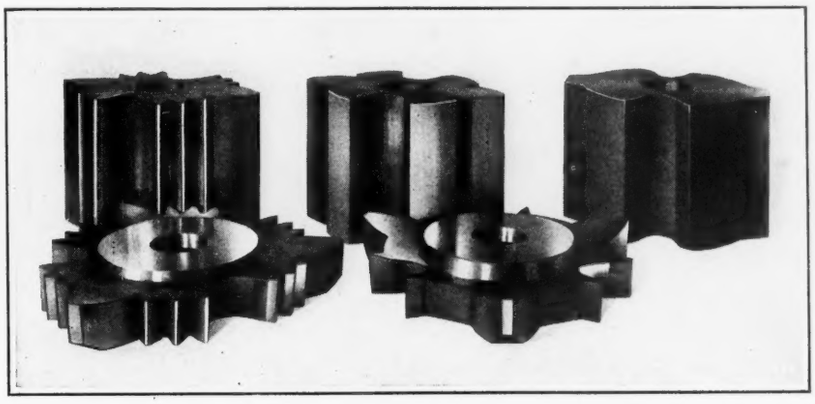


Fig. 1. Special Form of Pump Gear, and Cutters used for machining it on a Gear Shaper

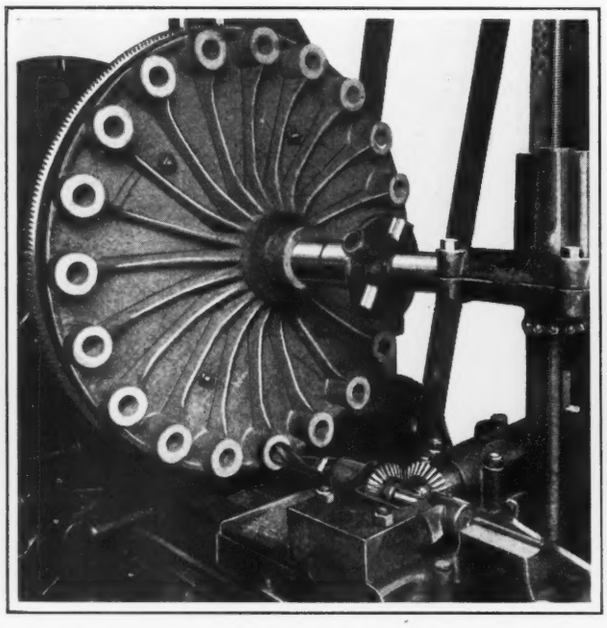


Fig. 2. Gear-cutting Machine converted into an Automatic Drilling Machine

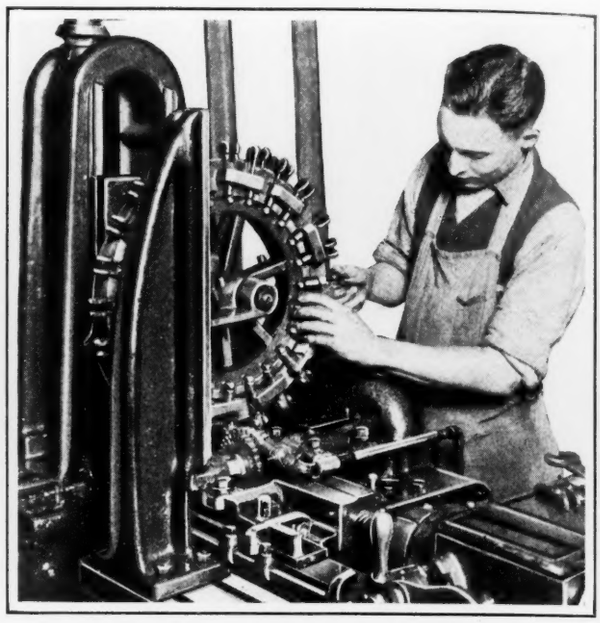


Fig. 3. Gear-cutting Machine being used as a Station-type Milling Machine

sides of the clutch simultaneously. The slots so formed may be seen on the gears located at the side of the work-holding fixture. After finishing all the slots on one side, the work is relocated for cutting the opposite sides of the slots.

Examples of Special Work Requiring a Generating Action

Gear shapers may be used for quite a variety of special operations, such as generating ratchet wheels and cams of different shape, generating splines of involute form on shafts and bushings, generating grooves in couplings or clutches, graduating the edges of circular parts, etc. For these operations, the machine is provided with a special cutter of whatever form is required. Fig. 7 shows a gear shaper arranged for shaping small pieces of the special shape shown at *A*. When the machine is in operation, the fixture is loaded on all sides, each pair of rods *B* holding a stack of blanks, as shown at *C*. This multiple type of fixture is designed to hold forty-eight pieces, which are finished during one revolution of the work-spindle.

Another interesting application of the generating principle to special work is shown in Fig. 8, which shows a gear shaper arranged for generating a square hole in an overarm support *A* for a milling machine. A three-cornered cutter *B* having convex sides is used. When the machine is at work, this cutter rotates in contact first with one side of the square hole and then another, and it takes very fine cuts at the corners, the feed becoming coarser as the cutter approaches the center of each side. The four sides are finished during one complete revolution of the cutter, the work being done accurately as well as efficiently. In fact, it is said that tolerances as small as 0.0005 inch can be maintained on a hole 3 1/2 inches square and 3 1/2 inches long. The fixture is in the form of a faceplate, the work being centered by stop-pins and held by the adjustable clamps shown.

By equipping a gear shaper with cutters of special shape, it may be used for cutting gears of odd form as well as cams or other parts which can be machined to advantage by a generating process. An example illustrating, in a general way, the possibilities of the gear shaper as a means of producing special shapes accurately, is shown in Fig. 1 which illustrates a special pump gear. This gear is produced from the rough casting seen at the right-hand side of the illustra-

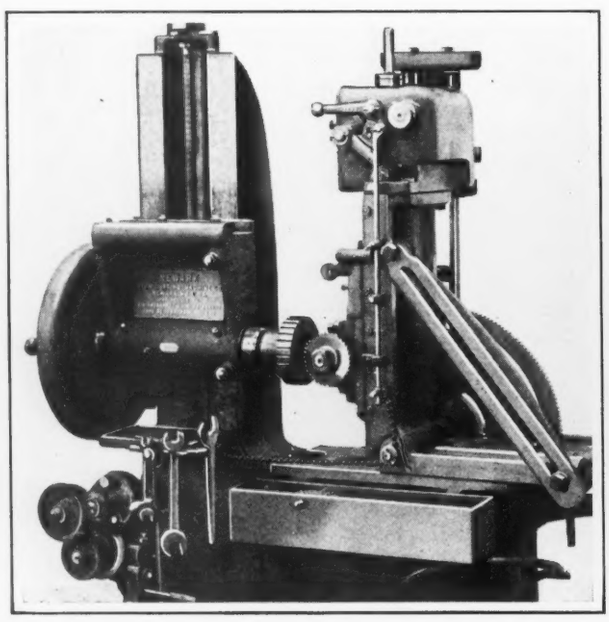


Fig. 4. Milling Slots in a Disk-shaped Part on a Gear-cutting Machine

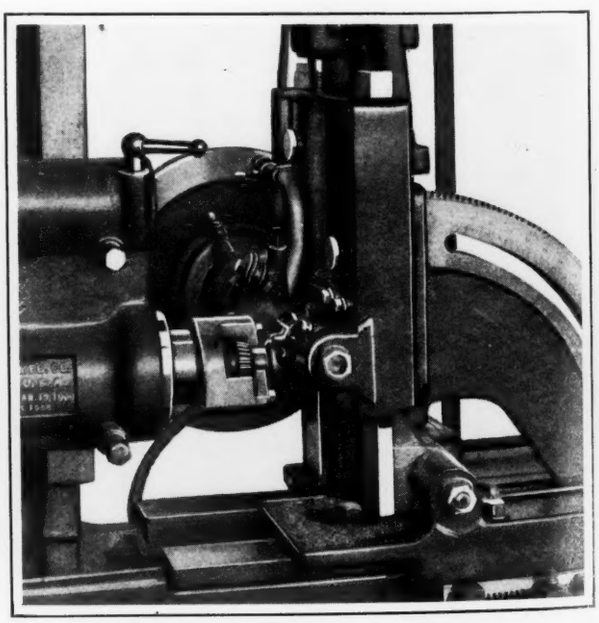


Fig. 5. Milling Clutch Teeth on a Gear-cutting Machine

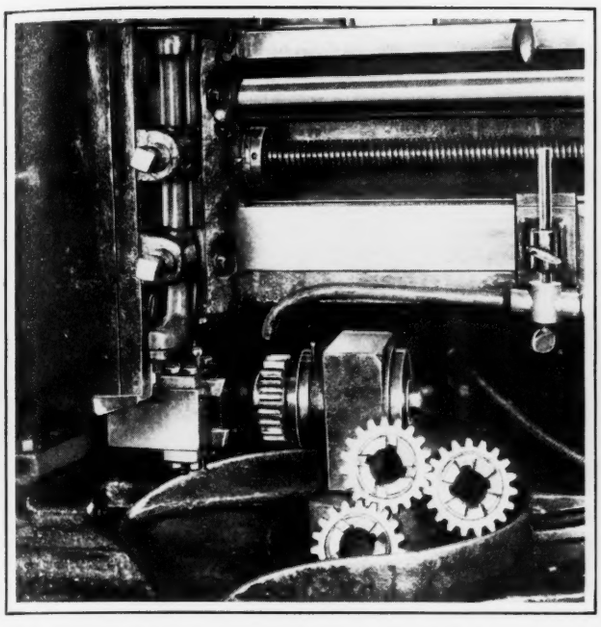


Fig. 6. Gear Shaper equipped with Duplex Slotting Tool for forming Clutch Teeth

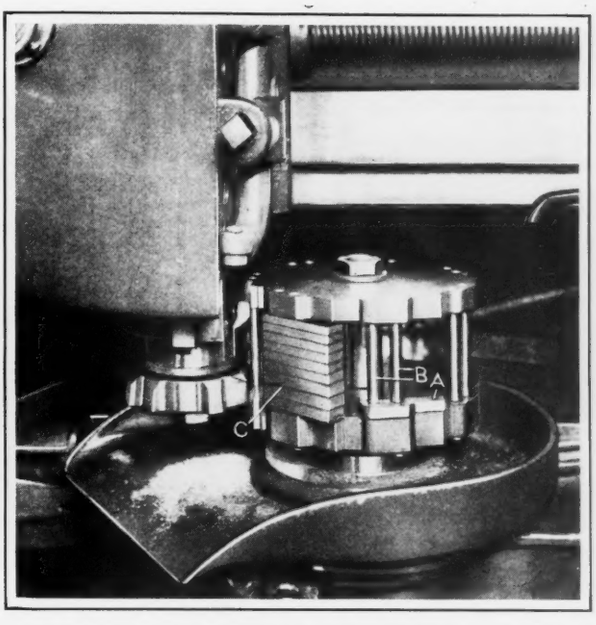


Fig. 7. Gear Shaper arranged for forming Stacks of Small Blanks held on a Multiple Fixture

tion. Owing to the large amount of stock to be removed, two cutters are used. The roughing cutter and the roughed out gear blank are shown at the center of the illustration, and a finishing cutter as well as a finished gear at the left-hand side. These gears have involute profiles, which are readily generated on the gear shaper by equipping it with cutters of the required form.

Cutting Splined Shafts by Hobbing

Gear-hobbing machines are very efficient for forming external splines on shafts, tubes, etc., by the hobbing process. The splines so formed may have either straight or curved sides, and if fillets or rounded corners are desired, they may be produced readily, assuming that the machine is provided with a hob designed with reference to the shape of the spline desired. The hobbing machine is geared according to the number of splines, and the operation is similar in principle to the cutting of gear teeth. Fig. 9 shows a hobbing machine generating multiple splined shafts. The shafts are cut at the rate of twenty per hour, and the operator also runs the machine that keyseats these shafts.

While the method of holding a shaft or tube in a hobbing machine must be varied more or less according to the size and shape of the work, nevertheless, the different devices illustrated in Figs. 10 and 11 may embody principles that can be applied generally. The methods illustrated have been used in connection with Lees-Bradner gear-hobbing machines. Diagram *A*, Fig. 10, shows a method of holding a shaft having centers at each end; it will be noted that one end projects back into the work-spindle. Attached to the work-spindle there is a driving plate *a* engaged by dog *b* (see also end view). The sleeve *c* fits into the tapered hole in the work-spindle and supports the inner center.

A method of holding a shaft that is not centered at either end is illustrated by diagram *B*. The outer end is supported by a bearing, and the inner end by a collet chuck which is operated by a draw-rod passing through the machine spindle. An extension on the forward end of this draw-rod engages the inner end of the work and locates it relative to the chuck. The lower view *C* shows a method of holding a tube on which splines are to be hobbed. The outer end is supported by a center, and the machine spindle is equipped

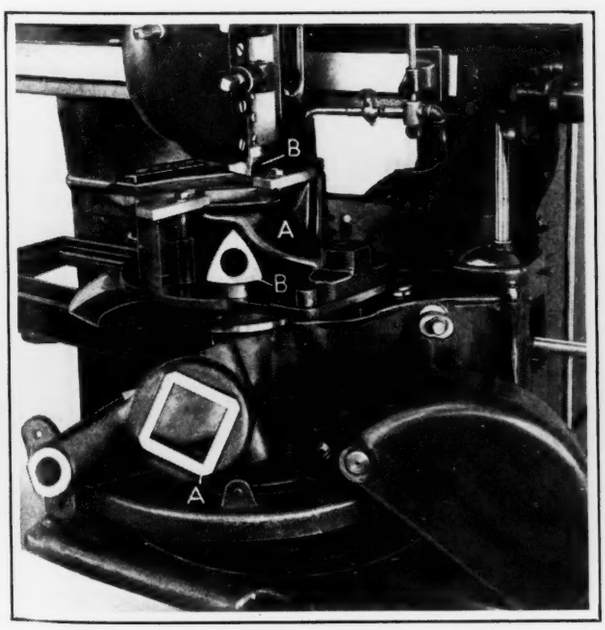


Fig. 8. Cutting Square Holes on Gear Shaper by Application of Generating Principle

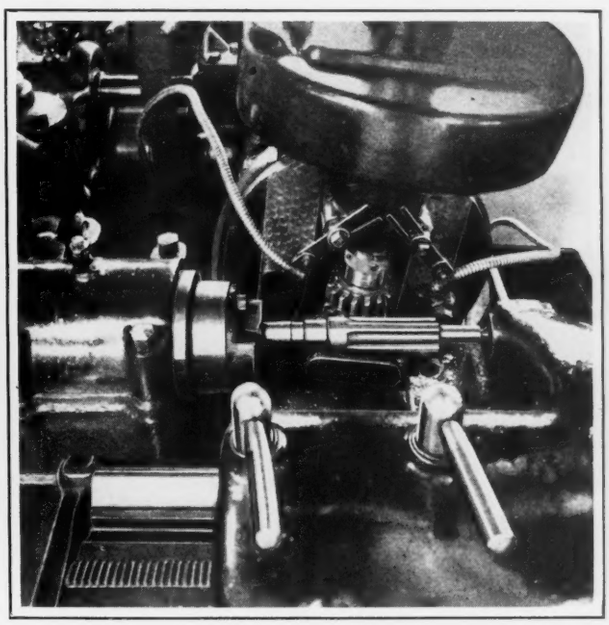


Fig. 9. Use of a Gear-hobbing Machine for generating Multiple Splined Shafts

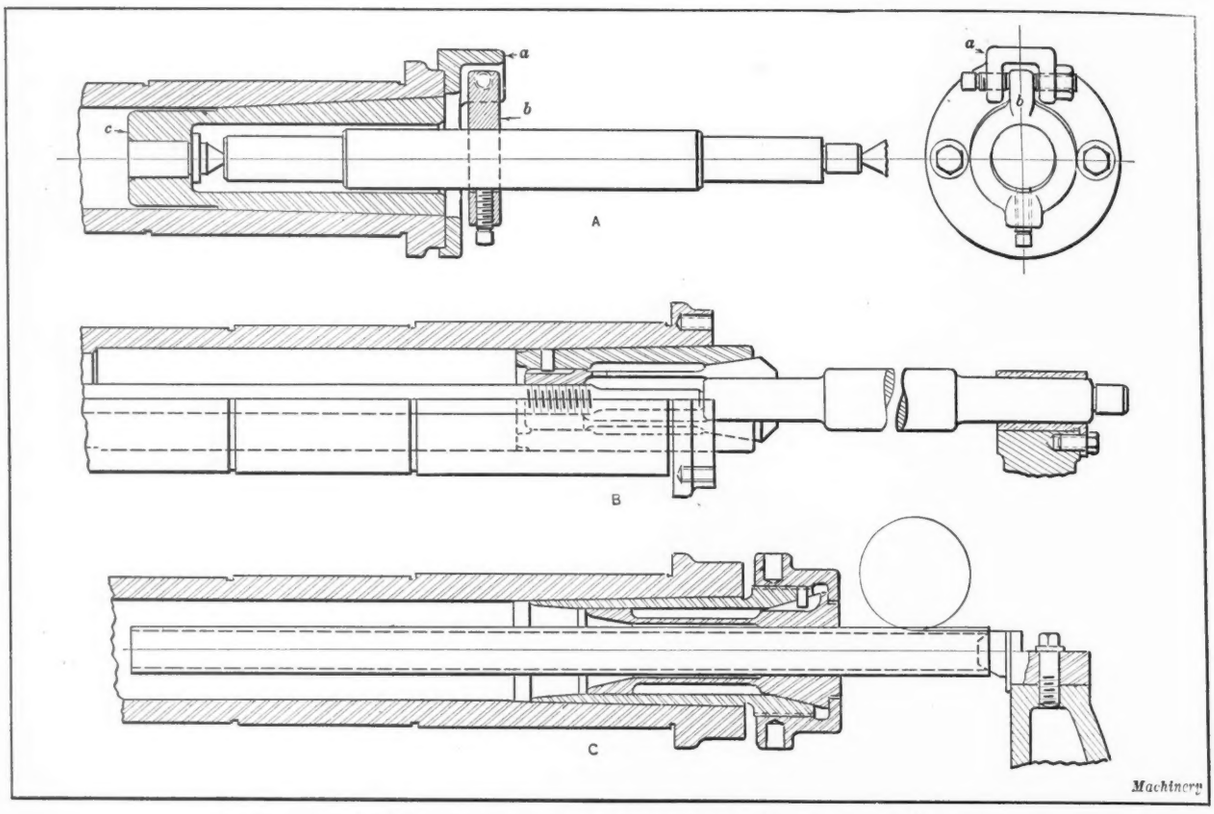


Fig. 10. Different Methods of holding Shafts and Tubes while forming Splines by Hobbing Process

with a collet chuck that is opened and closed by a sleeve nut. Diagram *A*, Fig. 11, shows a method of holding a shaft having splines that must be concentric with the center at one end and with an external taper at the other end. A regular machine center supports the outer end, and a special arbor having a conical seat is used for holding the taper end of the work. Diagram *B* shows a part that required a special type of clamping arbor in order to hold and drive the work and at the same time provide clearance for the hob. The arbor end of the shaft is gripped between two clamps which are tightened by the bolt shown.

Sprocket Cutting on Gear-cutting Machines

Gear-cutting machines of the type used for spur gears are naturally adapted for cutting various forms of chain sprockets, since the latter are similar to gears and may be considered a special form of gear so designed that the driving and driven members may be connected by a transmission chain instead of by direct meshing. Sprockets are often cut by the formed-cutter process on automatic gear-cutting machines. In cutting some kinds of sprockets, the number of teeth in the sprocket must be considered in selecting the formed cutter for milling the teeth, the same as when using formed cutters for spur gears. In other words, there is a series of cutters for each pitch to provide for the variations in the shape of the spaces between the teeth of sprockets of different sizes. There is also a universal type of formed sprocket cutter which may be used for any number of teeth of given pitch and roller diameter. This cutter is intended for sprockets having the form of tooth based on a constant pressure angle.

If a gear-hobbing machine is used for cutting small sprockets, a "universal" hob may be employed. This type is so designed that a single hob will cut any number of teeth of given pitch and roller diameter. In other words, these sprocket hobs have the same advantage as the hobs or other forms of cutters used for cutting gear teeth by a generating method. The universal sprocket hobs are designed to produce the American standard form of sprocket tooth, which is adapted to the hobbing process. The space angle of this tooth gradually decreases as the number of teeth increases, whereas the pressure and tooth angles gradually increase. The universal hob tends to produce these same changes, but not at the same rate.

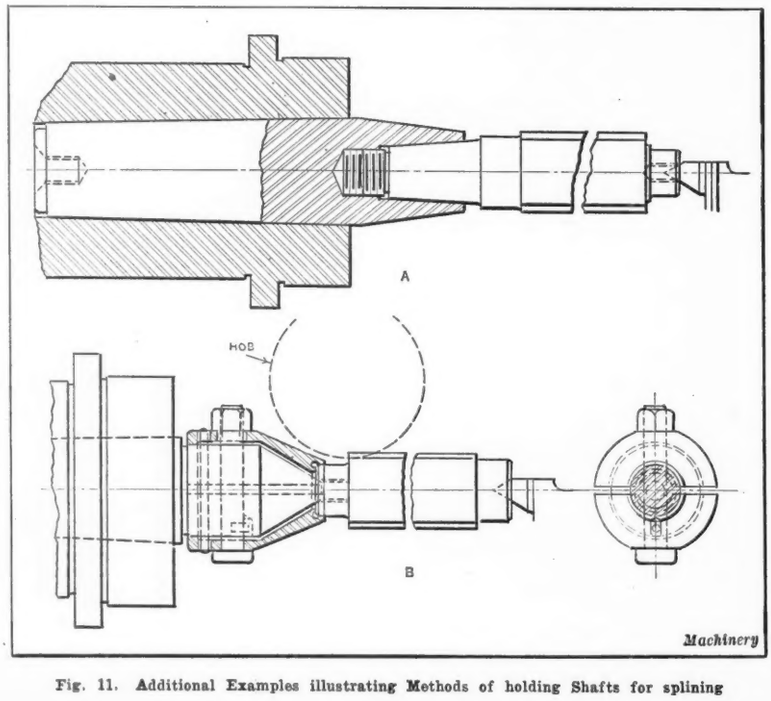


Fig. 11. Additional Examples illustrating Methods of holding Shafts for splining

* * *

A recent study of the mechanical and electrical energy developed in the United States and converted into man power, indicates that power equivalent to 3,000,000,000 men is produced in the power stations.

THE TESTING OF SHEET STEEL

At a recent meeting of the Detroit section of the Society of Automotive Engineers, E. F. Collins, of the metallurgical department of the Packard Motor Car Co., presented a paper on the testing of sheet steel. Briefly stated, the problem confronting manufacturers in the automobile industry is: Will sheet steel used in this industry meet the requirements for which it is intended, and can it be produced in presses without breaking, buckling, or showing a coarse structure at sharp corners? The answer to this question has been sought through a series of tests applied to samples of the material by the Packard Motor Car Co. Three test sheets are selected from different parts of every 1000 sheets received. After sections have been removed from the ends of these sample sheets, four test pieces are taken from each sheet at specified locations, and these samples are subjected to Erichsen, Rockwell, and tensile strength tests.

The general conclusions reached are that if the Erichsen values are uniformly more than 10.3 millimeters, if the Rockwell hardness B scale is between 25 and 40, the elastic-limit-tensile-strength ratio not more than 60 per cent, the elongation about 30 per cent, the microstructure of normal and uniform grain size, the grain boundaries are sharply defined, and the steel is clean, no trouble in forming deep-drawn stampings may be anticipated.

General Considerations Preceding Testing

In testing any material, the first and most important point to consider is the representativeness of the sample. If we are to obtain a true picture of the drawing qualities of a shipment of sheet steel, the samples from which that shipment is to be judged must be representative of the shipment; that is, the test specimens taken from each sheet tested must show the drawing qualities of all parts of the sheet. Assuming, therefore, that sheets have been selected from different parts of the lot to be tested and that specimens from these sheets represent the whole sheet, a true estimate of the drawing qualities of the shipment can be obtained.

Method of Taking Samples

Because of the method used in the manufacture of sheet steel, the task of selecting sheets that are an average of the lot is not easy, but, on the other hand, is not impossible. If three sheets are taken from different parts of each 1000 sheets received, and if the test results check, we can feel fairly sure that we have obtained an average sample. If one or more of these sheets give erratic results, other sheets are checked until we are sure that the figures are correct. Test specimens are cut from each sheet in the following manner. First, sections 3 inches wide are cut from each end of the sheet for the full width and are thrown away; then two sections 2 3/4 inches wide and of the full width of the sheet are cut off and marked Nos. 1 and 3. Next, a section 2 3/4 inches wide and of the full width of the sheet is cut off from a point near the center of the sheet and is marked No. 2. These specimens are used for the Erichsen and Rockwell tests, as will be explained later. Finally, a 2-inch strip is taken parallel with the direction of rolling at a distance of about one-third the width of the sheet from the outside edge and as near to strip No. 2 as possible. This is marked No. 4, and is used for the tensile strength tests.

Erichsen Tests

Erichsen tests are made about every 6 inches across the three 2 3/4-inch strips, and Rockwell hardness B scale readings are taken between each pair of Erichsen impressions. The tensile strength test bars used have a 1-inch test-section and measure 2 inches between the punch marks.

In the Erichsen test, the metal is held between the binder rings in a manner similar to that in which the blank is held by the pressure rings of a forming die, and the round-nosed plunger acts similarly to the punch of a forming die, so that a cup is formed; the depth to which this cup can be drawn before fracture occurs is recorded in millimeters. This value is representative of the metal affected, and as readings are taken across both ends and the center of the sheet, the assembled results give a good picture of the drawing quality of the entire sheet. The Rockwell hardness readings taken between the Erichsen impressions serve as a check on the Erichsen values obtained.

Result of Insufficient Annealing

One of the common and most serious conditions shown by this series of tests is the hard or insufficiently annealed areas in the centers of the sheets. These are often the cause of breakage, buckling, and coarse surface at the sharp bends. When photomicrographs of these areas are made, it is often found that a strained condition had been set up in the rolling that had not been eliminated by the annealing. Some sheets that give good Erichsen and Rockwell values will show remnants of this strained condition. It is interesting to note that, if the grain boundaries are sharply defined, the sheets will form in spite of their strained structure.

Our laboratory-test record cards are marked to show the outlines of several sheets, and the Erichsen, Rockwell, and tensile strength results are marked within these outlines in the same relative positions as are the areas of the sheets tested, so that after the results have been marked on the cards, a complete picture of the drawing quality of the sheets can be seen at a glance. Any low or high test areas in any of the sheets are easily noticeable. If the centers or ends give low Erichsen or high Rockwell values, trouble in forming may be anticipated. How serious these troubles will be depends largely on the nature of the stamping to be made.

In making tensile strength tests, the yield point is determined by reading the beam load that produces the first permanent set. Lines are scribed on the test piece exactly 2 inches apart. When this distance becomes greater than 2 inches and remains so after the load has been released, the yield point has been passed. This point is checked by the drop of the beam, the breaking load noted, and the amount of elongation measured.

Ratio of Yield Point to Ultimate Tensile Strength

An interesting and important quality factor has been developed which helps the judging of the drawing quality of sheet steel—namely, the ratio of the yield point to the ultimate tensile strength. For instance, if the yield point is 20,000 pounds per square inch and the ultimate tensile strength 40,000 pounds per square inch, this ratio would be 50 per cent. The width of this zone is important, because no permanent set or elongation takes place until after the yield point has been passed and, obviously, no work can be accomplished after the breaking point has been reached. The greater the distance is, therefore, between the yield point and the breaking point the greater will be the ability of the steel to have useful work performed on it.

Take two stampings, for example, one of which begins to form after a load of 20,000 pounds per square inch has been applied to it and breaks when a load of 40,000 pounds per square inch has been applied, and a second that does not begin to form until a load of 30,000 pounds per square inch has been applied, yet breaks at the same load of 40,000 pounds per square inch. In the first instance, a load of 20,000 pounds per square inch has done useful work, while, in the second case, a load of only 10,000 pounds per square inch has been effective.

The microstructure of sheet steel is a good check on its physical properties. It is especially useful in explaining low test results or why a stamping is defective. Inclusions; impurities, such as phosphorus at the grain boundaries; large grain size near the outside with small grain size at the center, caused by annealing ferrite that has been critically strained by cold-working; and the insufficiently annealed condition of the centers or ends of some sheets, are among the causes of failure.

Coining, Forming and Embossing Dies

By C. C. HERMANN, President, Hermann Associates Inc., Engineers, Rock Island, Ill.

IN this article, a class of dies known as forming and embossing dies, which are similar in some respects to drawing dies, will be described. Strictly speaking, the embossing die does not change the thickness of the metal. There is supposed to be a hollow on one side of the die for each raised portion on the opposite side. Dies in which the metal is drawn during the shaping operation are generally known as coining dies.

In Fig. 1 is shown a set of dies used in the production of a copper coin bearing the insignia of a fraternal order. The coin is blanked from sheet copper, sufficient pressure being exerted upon it to cause the metal to flow into the various depressions in the punch face and die face. The punch face contains the reverse of the coin face and the die contains the reverse of the coin back. That is, wherever a raised portion appears on the coin, there is a corresponding depression on the die.

Brittle metals cannot be coined cold with any degree of success. The metal must be ductile and flow readily. The coining of badges, medals, and emblems is done by the cold process. When a thickened rim is desired, the coin cannot be blanked in the coining operation. In this case, the blanks are first cut from the sheet, and then rolled between grooved jaws in order to form a rounded and thickened rim. The edge of the coin may be reeded or left plain. If reeded, the dies must also have the reeded design so that the metal can be forced into the recesses.

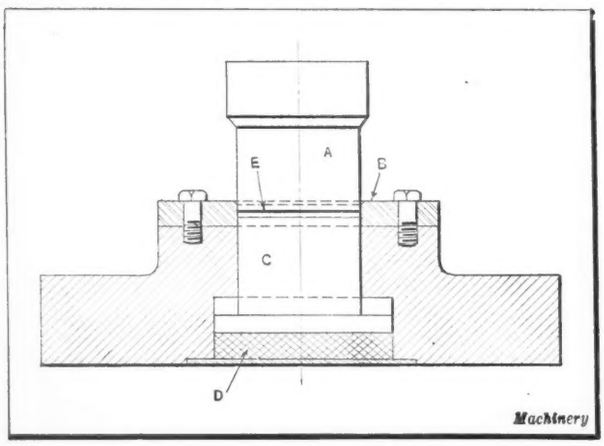


Fig. 1. Type of Die used in producing Copper Coins

The die shown in Fig. 1 consists of three pieces, namely, the punch, or upper die *A*, the collar *B*, and the lower die *C*. The lower die rests on a spring or rubber cushion *D* and its travel is limited, so that it serves as an ejector of the finished work. Collar *B* is slightly beveled to facilitate centering the work in the die. If the work is blanked out at the same time it is coined, the edge of the collar is left straight to form a shear. The upper die member then serves as a punch as well as a die.

The press used is of the single-acting, adjustable ram type, and the space *E* between the upper and the lower dies is the exact thickness of the finished coin. The advantage of doing this work on an adjustable press is that the pressure exerted on the work may be readily adjusted to take care of variation in the metal. If the pressure is too great, the coin will come out of the die with a fin running up between the die and the collar. In case the edge of the work is to be rounded, this will not be objectionable, except from the standpoint of material used.

Embossing Dies

Embossing dies differ from coining dies in that the latter generally have different designs on the upper and lower dies. An embossing die is one having the same design on both the upper and lower dies, one being the reverse of the other; that is, the lower may have the depressed design and the upper the raised design. The mucilage bottle cap shown at *D*, Fig. 3, is a typical illustration of this class of work. Two methods of making the cap will be described. The first consists of producing the shell *C* in one stroke of the machine and forming the threads in another stroke.

The second method consists of producing the cap, including the curling of the edge, under a die, and then rolling the threads and reeding the edge by means of a rolling operation. The die shown in Fig. 2 is used in drawing and curling the edge of the shell. It consists of a blank-holder *A* which is provided with a shear edge at *H*. This permits the blank to be cut from the sheet stock and drawn at one stroke of the press. The ring blanking die is shown at *B*. The stock is blanked out and then held against the top surface of the die *C* while the punch *D* forms it into a shallow cup and at the end of the stroke curls the edge.

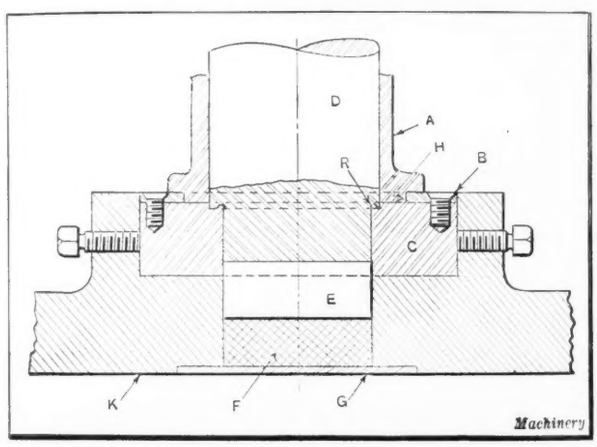


Fig. 2. Die designed for blanking and forming Shell C, Fig. 3

The turning of the edge is accomplished by the curling recess *R* in the punch, and the corresponding recess and rib on the die *C*. A cylinder of steel *E* which just fits the bored hole in die *C*, rests on a rubber cushion *F* and is held in the lower die by the plate *G*. This cylinder constitutes a stripper which forces the work out of the lower die while the stock is being removed from the punch. Die *C* is held in a die-holder *K*, which is secured to the base of the press.

Rolling Threads

The next operation is to produce the threads in the cap, complete the curling operation, and form the reeding. Rolling is one method by which this can be done. The rolling tools required are shown at *A* and *B*, Fig. 3. A right hand thread of the pitch required on the cap is turned on one end of the tool-steel arbor *a*. The outside diameter of the threaded portion must be smaller than the inside diameter of the cap by an amount equal to twice the depth of the thread in order that the cap can be removed after rolling. The end of this arbor has a series of serrations that conform with the reeded section of the cap.

A left-hand thread is cut on the roller *b* which is mounted in the holder *e*. The threaded roller *b* is made the same diameter as the arbor plus the thickness of the stock to be

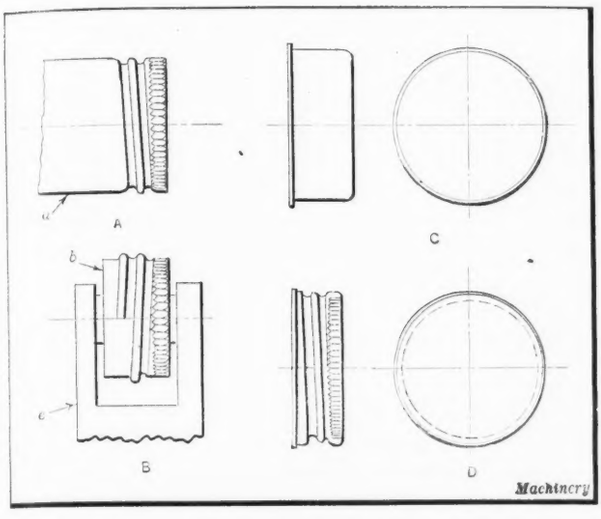


Fig. 3. (A) and (B) Thread-rolling Tools; (C) Metal Shell; (D) Shell C after Thread is rolled

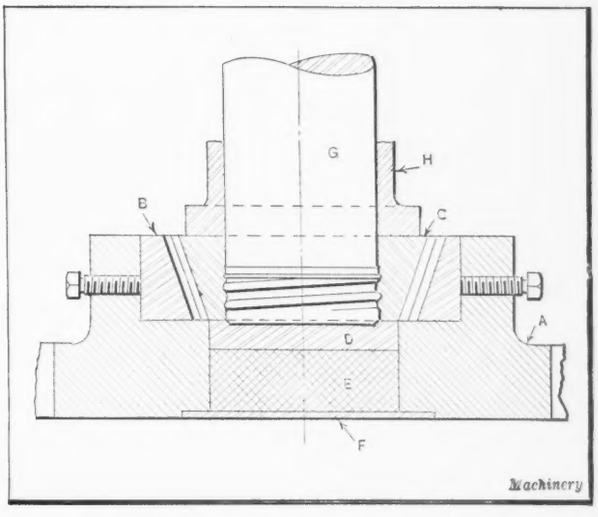


Fig. 4. Thread-forming Die designed to form the Threads on Cap shown at D, Fig. 3

worked. The outer end is also serrated to match the arbor. The arbor *a* and the roller *b* are both hardened. The arbor is held in a lathe chuck and the rolling tool is mounted on the cross-slide in such a manner that it can be swung toward and away from the arbor. The cap is placed over the end of the arbor and the outside tool brought up against the work. Thus the thread is rolled on the cap and the reeding completed in one operation. The work is removed and replaced by another cap without stopping the arbor. The curled edge is closed by the shoulder of the outside tool or roller at the same time that the threads are rolled.

Thread-forming Die

A second method of performing the same operation is by the use of the die shown in Fig. 4. Referring to this illustration, the base block *A* contains the ring die *B*, which is bored out to fit the taper of the split die *C*. Die *C* rests on the plate *D*, which is supported by a rubber or spring *E*, held in the base by the plate *F*. The punch is shown at *G*, and the stock-holder at *H*. The purpose of the spring or rubber pad *E* is to raise the work above the surface of ring *B* to facilitate its removal from the die. Die *C* is provided with threads and serrations that conform with those required on the cap.

In operating the press, the work is placed in die *C* and the halves brought together. A small rubber cylinder is then placed within the cap. As the ram moves downward, the holder *H* comes in contact with die *C*, forcing it down on its seat by compressing the rubber pad *E*. Further movement of the ram causes the rubber cylinder within the cap to be expanded by the plunger *G*, which forces the metal into the threads of die *C*. The removal of the work is readily accomplished, since die *C* opens up when raised above the surface of ring *B*. Several rubber cylinders are kept at hand, and as the work is removed, a new piece is placed in the die without waiting to remove the rubber from the piece just made.

Without some means of holding the split die *C* when it reaches the upper position and opens, considerable time would be lost in placing the work and die together for the next operation. This is accomplished by providing ring *B* with two T-slots and the halves of die *C* with corresponding slides. These T-slots are located diametrically opposite each other, and are not shown in the illustration. As die *C* is raised, it automatically opens sufficiently to allow the work to be removed.

The work is set in the die and centered by the depression in the plate *D*. Die *C* must be slightly higher than the height of the cap in order to provide for a sufficient volume of rubber to expand into the first thread of the cap, but not so high that it will expand over the surface of this die. The curled edge of the cap is closed by the expansion of the rubber around the top, and at the same time is slightly expanded at this point, making it easier to start the cap on the bottle or other object on which it is to be used. Any lettering on the surface of the cap is produced by having plate *D* suitably engraved.

Embossing Die for Button Top

A typical application of the embossing type of die is found in the production of various ornamental designs on button tops and similar work. The button top formed from sheet brass, with an ornamental star design embossed on its surface, as shown at *W* in Fig. 5, is a good example of this class of work. With a double-acting press available, the blank for the button top can be punched from sheet stock and the piece completed in one stroke by the die shown in Fig. 5.

The ring die *A* is secured to the die member *B*, which is held in the lower base block *C*. Within die *B* is a removable center *D*. This construction permits plug *D* to be removed while working or engraving the design on its face. The ram *E* is also provided with a removable end piece *F* in which the design is engraved and which may be renewed without the loss of any considerable amount of steel. The stock-holder shown at *G* is provided with a shear edge corresponding with a similar edge in the ring die *A* which blanks out the button.

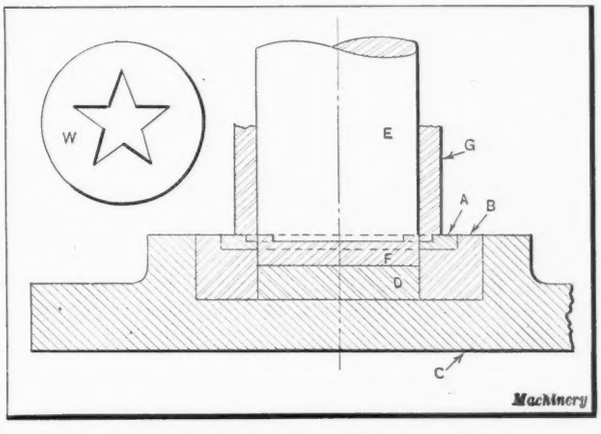


Fig. 5. Die used to blank and emboss Button Top

There is a local stretching and compressing of the metal in all embossing operations. The amount of stretching and compressing depends upon the dimensions of the design and the amount it extends above or below the surface. Occasionally the design must be worked over from an experimental stage until a piece can be produced without tearing the metal or causing excessive wrinkling at some points. The difficulties may occasionally be eliminated by the selection of a slightly

tougher material or other changes in the material specifications. Practically every problem has its own limitations, and the design must be considered with respect to the material available. Sharp corners and angles must be avoided as far as possible, which makes it extremely difficult to produce Gothic designs, except where the flow of material is entirely in one direction; that is, where there is no combination of stretching and compression.

The working surface of the dies will affect the results in a material way. For example, in some work one die surface must be left soft and in others, both surfaces may be hardened. The degree of hardness of the surface may be varied in order to eliminate some of the difficulties. Dies for the production of an accurate design are best worked out experimentally. With the type of die shown in Fig. 5, changes in the engraved design can be made at a minimum expense for material and labor.

Making Coining and Embossing Dies

The processes of making coining and embossing dies are similar in some respects. In the coining die, the letters and figures are generally cut directly in the surface of the steel. Since the upper and lower designs are generally different, both members of the die must be engraved; that is, one die cannot be made from the other, as may often be done in the case of embossing dies.

Embossing dies are generally made by the hob method in the case of comparatively small dies, and by die-sinking in the case of large dies. The latter method is also used on small dies, and not infrequently we find a combination of the two methods employed. The hob is comparatively easy to make, because the design stands out in bold relief. It is made of tool steel, the face of the steel being first blued and the design traced thereon, after which the stock is cut away, leaving an outline of the design. The raised surface is then worked over with chisels, files, and gravers until the design is complete. In this case the design is the exact counterpart of that which will appear in the finished work. The hob is then hardened.

The die-block is first recessed on a die-sinking machine or in some other manner until the recess conforms approximately to the desired outline. The hob is then placed in the recess and driven down by means of a drop-hammer or heavy sledge until the design in the block is shaped to suit. Then the die is polished and hardened.

The next operation consists of making the upper part of the die or the punch. When the metal to be embossed is comparatively thin, the punch may be made direct from the lower die. To do this, a piece of tool steel is pointed to approximate the design of the die, heated to a bright red, and driven into the die recess until the design has been transferred to the punch end, after which the punch is removed and allowed to cool. Polishing then completes the punch. After the scale has been removed and the design polished, the punch design will be slightly smaller than the die design. This is the condition desired. Before hardening the punch, however, it is well to test the die by placing a sheet of soft metal between the two members and driving them together. This procedure permits further corrections in case the punch allows too much clearance at some points. Reheating should be avoided, since the repeated scaling may cause the punch to become too small.

* * *

Lloyd's Register of Shipping shows that the shipbuilding industry is now at the lowest point since the war. The building of steamships has fallen steadily for several years, but on the other hand, there has been an increase in the number of ships being built to be driven with oil engines. This trend has been so pronounced that at present nearly one-half of the world's shipbuilding consists of oil engine driven ships or "motor ships," as they are frequently called. The reason for the popularity of the oil engine driven vessel is its economy of operation.

PRODUCING TEST BARS IN QUANTITIES

In the shops of the Gould Coupler Co., Depew, N. Y., so many test bars of steel castings are made that it has been found economical to tool up a turret lathe for finishing them. These test bars are made from very rough pieces, such as shown at *B*, Fig. 1, which are cut from the castings by means of an oxy-acetylene torch. The pieces usually have an uneven cross-section that results in an unequal cut being taken by the turning tools at the beginning of the operation, and frequently there are hard spots in the metal which tend to make the operation more difficult. At *A* is shown a test bar that is complete except for cutting off from the surplus stock.

Fig. 1. Test Bar shown at A produced from Rough Piece at B

Fig. 2 shows the tooling equipment employed in the operation, both the machine and the equipment having been built by the Warner & Swasey Co., Cleveland, Ohio. Before the rough pieces are delivered to this machine, the corners are ground off on a floor grinder sufficiently to get beneath the scale and to round one end so that it may be inserted into a bell-mouthed tool on the hexagon turret. This bell-mouthed tool chamfers the end, and then a single cutter turner is used to rough-turn the part. This constitutes the most interesting step of the operation because of the unevenness of the cut. On some pieces as little as 1/8 inch of stock may be turned from one side while 1/2 inch of stock is being removed from the other side.

After the rough-turning, the overhanging end of the bar is centered with the piece in the machine and then the center is used, as illustrated in Fig. 2, to support the overhanging

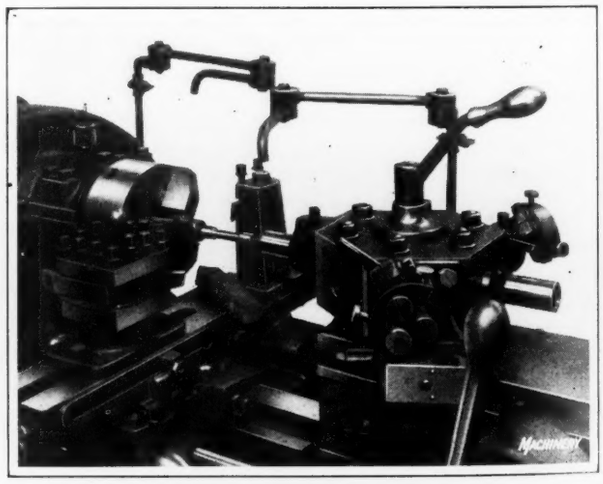


Fig. 2. Set-up of Turret Lathe for machining Test Bars in Quantities

end during the finishing cuts. Three finishing cuts are taken by a tool mounted on the square turret. Another tool on the square turret is employed for turning the fillets. All of the equipment is standard. The time taken in producing the test bars from the rough pieces averages 12 minutes, as compared with 30 minutes by the former method.

Notes and Comments on Engineering Topics

An interesting proposal has been made to dam a part of the Bay of Fundy in Maine, where the tide rises and falls twenty-seven feet. The idea is to catch the tide in the upper bay when it rises and then to allow it to flow out again, passing through turbines generating power. It has been estimated that the project planned would generate 500,000 horsepower.

In a recent issue of the *Scientific Monthly*, Dr. Edwin E. Slosson recalls the almost successful attempt of the Indiana Legislature to establish a value of pi equal to 4. This extraordinary piece of legislative presumption was quashed by the personal efforts of a member of the Indiana Academy of Sciences who happened in at the Lower House during the third reading of the bill and who made a sufficiently active canvass of the senate that night to show some of its members the absurdity of the proposed action.

The position of importance that the United States occupies as an exporter of machinery belting is brought out in a report just issued by the Department of Commerce. According to this study, somewhat over 5,000,000 pounds of machinery belting, or nearly 20 per cent of the total shipped from all producing countries, came from the United States in 1924. Of this total, it is pointed out, 71 per cent was classified as rubber belting, 22 per cent as leather, and 7.5 per cent as cotton belting. The value of these exports was approximately $3,925,000.

The engineer must be a planner of his work. He must know how to handle men. He must know economic theory and the methods of applying it to the solution of the problems that he encounters in his work. History, philosophy, psychology, and politics have their places in an engineering curriculum. All these subjects have a value in training the engineer of vision. Each one of these subjects plays a part in giving experiences of the past on which to predict results of the future. Each one will help in the human relations which exist in engineering in the broad sense; men as well as materials must be used by the engineer in all of his activities.—*A. M. Greene, Jr., Dean of School of Engineering of Princeton University.*

The remarkable development in motor bus transportation that has taken place during the last few years is in evidence in new motor buses recently built by the Pierce-Arrow Motor Car Co. for a California stage company. These buses make a daily run between Los Angeles and San Francisco on a schedule of 14 hours and 40 minutes and resemble in their equipment railway cars more than past conceptions of buses. They are provided with a compact kitchen from which hot and cold meals are served, the armchairs of the bus being arranged so that the trays on which the meals are served are fitted to the arms. Like railway cars these buses are also fitted with a smoking compartment and a lavatory.

Twenty-five billion bolts, nuts, and rivets are produced annually in the United States, having a sales value of nearly $200,000,000. In the manufacture of these products, 1,250,000 tons of steel are used. The cost of containers for shipping, together with packing and storing, is estimated at about $12,000,000 annually. A study is now being made by the bolt, nut, and rivet manufacturers' association, in cooperation with the Division of Simplified Practice, Department of Commerce, Washington, D. C., of the subject of standardizing packing methods with a view to reducing the number and sizes of packages, and determining upon the best method of packing and handling shipments of this kind in a uniform manner.

The highest aerial tramway in the world, having a total length of more than five miles, is used by the Carocoles Tin Co. in Bolivia for transporting ore from the mines to the mill. The mines are located at an altitude varying from 15,000 to 17,900 feet above sea level, while the mill is in the valley below at an altitude of between 11,000 to 12,000 feet. Two cables suspended from steel towers are used, one stationary over which the buckets move, and the other moving for controlling the travel of the buckets. The buckets travel at intervals of approximately 1000 feet and are moved downward after starting by the weight of the ore which they contain. The cableway is also utilized for transporting supplies from the mill to the mines, in which case motors are used to furnish power for the drive.

During the fiscal year ended June 30, 1925, the Bureau of Standards at Washington completed 173,261 tests, according to a report to Secretary Hoover. This represents a considerable increase over previous years, 115,729 tests having been completed in 1923, and 135,852 in 1924. The fee value of the work is $547,543.35. This is also an increase over past years, the 1923 and 1924 figures being $419,915.70 and $509,850.87, respectively. All income so received is turned back into the Treasury of the United States, the expenses incurred in the tests being absorbed by the annual Congressional appropriations for the bureau's maintenance. A great variety of materials and devices were tested, including precision tapes, weights, clocks, electrical instruments and lamps, thermometers, fire resistant safes and roofing, aeronautic instruments, automobile tires, fusible boiler plugs, and leather.

The largest steam condenser ever built, to be operated in conjunction with a 115,000-horsepower generating unit, larger than any other single unit ever constructed, has been ordered by the Brooklyn Edison Co. from the Westinghouse Electric & Mfg. Co. The condenser and turbine equipment will be made at the South Philadelphia plant, while the electric generator will be delivered from the East Pittsburg Works, the whole installation calling for an outlay of more than one and one-quarter million dollars. When completed, this engine will be about fifty times as large as the biggest steam units produced twenty-five years ago. The total weight of the generating unit will be one and one-quarter million pounds, with an additional 1,000,000 pounds for the condenser. The low-pressure spindle, or rotor, alone will weigh 126,900 pounds. The largest unit built heretofore was one of 70,000 kilowatts, or approximately 95,000 horsepower, which was installed in the power plant of the Interborough Rapid Transit Co., New York City.

The condenser ordered for use with this new unit will have 80,000 square feet of cooling surface. It will contain 12,920 tubes, each 24 feet in length, or equivalent to a continued tube length of 58 1/2 miles. The length of the shell will be more than 34 feet, while the height will be about the same as an average two-story house. The condenser will be equipped with two pumps of a combined capacity of 100,000 gallons per minute, or close to 150,000,000 gallons per day, when operated the full twenty-four hours.

UNIT TOOLING

By "unit tooling" is meant the locating of an entire series of tools used for machining a part, in permanent relation to each other. This is accomplished, in the case of a turret lathe, by providing a special arm or multiple tool-holder, which is fastened to the turret. It is evident that the employment of a unit tooling arrangement is a production expedient only when quantities of work of a standard nature are handled. The expense of making such a tool-holder would not be warranted for special classes of work on which no repetition orders are likely to be received.

POWER PRESS RATING

The method of rating power presses varies considerably among different manufacturers. Some rate their presses by number, the number used bearing a certain relation to the diameter of the crankpin. For instance, when a flywheel press has a crankpin, say, 5 inches in diameter, the rated capacity may be the square of the diameter, or 25 tons pressure. The number given to a press, however, does not always indicate its capacity, which may depend, to a certain extent, upon the gearing. Other manufacturers use the diameter of the flywheel and its maximum velocity as a basis upon which to rate the capacity of the press. Another method is to calculate the diameter of the crankpin in practically the same manner as a beam supported at both ends, the cross-section of the crankpin being determined by what the tonnage would be at the dead point. In other words, the dead-point tonnage is used to indicate the tonnage of the press. By this method, however, the tonnage has no direct relation to the number given, which is chosen arbitrarily. According to another method, the nominal capacity of the press in tons is equal to three and one-half times the square of the diameter of the crankpin. For instance, a press having a 2-inch diameter crankpin would exert a pressure of 14 tons. The nominal tonnage of a press may also be related to the strength of the frame and crankshaft, and establishes a standard stroke; any increase in the stroke changing the capacity of the press.

WIPED JOINT

A form of joint known as a "wiped joint" is made by plumbers in the following manner: The parts to be joined are first tinned at the points of contact to remove the oxide, and then firmly placed and secured in position. The melted solder is poured on the parts for the purpose of heating them. As the parts become hot, the solder becomes cool, taking on the pliable form mentioned, and is easily manipulated by the mats in the hands of the mechanic, when the joining is completed. The wiped joint is not to be recommended, and there is no good reason for maintaining this method of making plumbing connections. There are a number of mechanical joints that have the merit of cheapness, ease of application, and that can be readily disconnected in case of needed repairs.

LITHOLITE

Litholite is an electrical insulating material made from paper pulp into sheets and pressed into any desired form. Litholite is tough, but inflammable. It is softened by the action of sulphuric acid and distilled water, and is reduced to a pulp if immersed in caustic soda. Approximately 20,000 volts are required to puncture a sheet about 3/16 inch thick. Litholite is used for tubing, bushings, washers, and commutator rings.

TAPER HOBS

Hobs that are tapering on the leading end and that feed tangentially are especially adapted for cutting worm-gears of large helix angle. The use of a taper hob makes it possible to cut worm-gears more rapidly than with a fly cutter, and also very accurately, provided the hob itself is accurate. The taper-hob method also increases the rate of production as compared with the use of straight hobs which are fed in radially. In the taper-hob method, the rotation of the hob relative to the blank, as the hob moves tangentially, is such as to advance or screw the hob slowly along its own thread. The action of the hob is the same as that of a fly cutter, and machines adapted for the fly-cutter method may also be equipped with taper hobs. The leading teeth on the hob are tapering, and they should be designed to increase progressively in width as well as in height from the small to the full-size end. The tapering or leading end performs a roughing operation, whereas the full-sized teeth take light finishing cuts, thus preserving their accuracy and insuring well formed teeth. The tangential feeding movement continues until the large end of the hob passes out of contact on the side opposite the starting point.

QUADRIC INCH

The expressions "quadric inch" and "quadric foot" are sometimes used in connection with values denoting the moment of inertia. The moment of inertia is expressed by the fourth power of a length dimension; hence, the expression "quadric inch, foot," etc., according to whether the inch or foot is used as the unit length. In expressions containing the moment of inertia, the quadric dimension is frequently abbreviated $in.^4$, $ft.^4$, etc. The expression is not very commonly used.

PLANISHING

A planishing operation is one involving the use of a hardened tool having a very smooth working surface which imparts a fine finish to a steel or other surface by either a rubbing or a rolling process, depending upon the nature of the work. The tool used may either be in the form of a hand-tool having a smooth end which is held into contact with the rotating surface, or it may consist of a hardened and polished roller or of a pair of rolls. In rolling finished shapes in steel mills, the pass next to the last one is called the "planisher," or sometimes the "leader." Planishing rolls are also used for certain finishing operations on sheet metals. For example, the second pair of rolls used for finishing coin metal by cold-rolling prior to minting, are known as planishing rolls. Cylindrical parts which have been turned in the lathe are sometimes finished by rotating in contact with a hardened and polished roller, the object being to obtain a dense surface and a smooth finish. This planishing operation, however, is not common, and is confined largely to certain railroad shops where it is applied to the fitted ends of crankpins and axles. In metal spinning, a "planisher" is used for planishing or burnishing the surfaces of spun parts. This tool is manipulated by hand, and has a hardened and polished end which removes unevenness as it rubs over the rapidly rotating part, the surface of which is made smooth and dense. The term "planishing" is also applied to a hammering operation, which consists in giving parts a dense, smooth finish by a rapid succession of blows delivered by the highly polished dies or hammers of a planishing hammer. Planishing is similar to burnishing so far as the general principle of the process is concerned, and the two terms are used interchangeably for certain operations.

GLAZED GRINDING WHEEL

A wheel is "glazed" when the cutting particles have become dull or worn down even with the bond, which latter is so hard that the abrasive grains are not dislodged when too dull to cut effectively. Glazing may indicate either that the wheel is too hard for the work, or that the wheel speed is too high. The remedy, then, for glazing is to decrease the speed or use a softer wheel.

LEAD BATHS

The lead bath is extensively used in connection with the heat-treatment of steel, but is not adapted to the high temperatures required for hardening high-speed steel, as it begins to vaporize at about 1190 degrees F., and, if heated much above that point, rapidly volatilizes and gives off poisonous vapors. Lead furnaces should be equipped with hoods to carry away the fumes. Lead baths are especially adapted for heating small pieces that must be hardened in quantities. Gas is a satisfactory fuel for heating the crucible. It is important to use pure lead that is free from sulphur. Melting pots for molten lead baths, etc., should preferably be made from seamless drawn steel rather than from cast iron. Cast-steel melting pots, if properly made, are as durable as those made of seamless drawn steel.

TIN PLATE

Tin plate is produced from steel sheets (generally from No. 16 to No. 38 gage) which are coated with tin for protection from corrosion. After the sheets are rolled in the usual manner, they are pickled to remove the scale, washed with water to remove the acid, and then annealed. They are afterward cold-rolled to a perfectly smooth surface, again annealed, pickled, and washed, and passed through molten tin by means of from four to six pairs of rolls immersed in it. Standard sizes of tin plate are 14 by 20 inches and 20 by 28 inches.

DEMAGNETIZER

Hardened tool-steel parts that have been held on a magnetic chuck become permanently magnetized, and this is also true, in a slight degree, of cast-iron parts. This residual magnetism is objectionable for some classes of work, and a device known as a "demagnetizer" is used for removing it. This apparatus consists of an iron base upon which is mounted a wooden box containing a revolving member in the form of a magnet held in a rotating framework; a pulley for rotating the demagnetizer is provided. The cover of this apparatus is detachable and supports a mass of laminated sheet-iron plates which are in contact with two metal plates attached to the top cover. After the apparatus is set in motion, all traces of magnetism may be removed from the work by simply moving it several times in and out of contact with these metal plates. The phenomenon of demagnetizing may be briefly explained as follows: The iron plates at the top of the apparatus represent the poles of a magnet in which the polarity is rapidly reversing. This reversal of polarity is transmitted to the work in contact with the plates. At the moment of reversal, however, there is a neutral point in which, for an instant, there is no magnetism. In removing the work out of a strong magnetic field to a weaker one (by lifting it away from the apparatus), it has moved a certain distance during the time that the magnet is neutral, and, when next charged, being in a weaker field, it does not take as strong a charge as before; thus, by a repetition of this movement, the magnetism is finally removed entirely.

GEAR PLANERS OF TEMPLET TYPE

Very large bevel gears, and many of medium size, are cut by using gear planers of the templet or form-copying type. Such machines are also used in some shops for cutting the larger sizes of spur gears. Inexpensive forged tools are used on these machines and the forms or templets that control the path followed by the tools when taking finishing cuts are selected (in the case of bevel gears) according to the pitch cone angle, by referring to a chart accompanying the machine. The templet principle provides a relatively simple method of cutting gears of medium and large sizes, especially in gear shops or wherever a variety of pitches or sizes is encountered.

ALUMINUM-COPPER ALLOY CASTINGS

As far as can be estimated from available figures, according to a publication "Preparation of Light Aluminum-Copper Casting Alloys," published by the United States Bureau of Mines, about 97 per cent of all aluminum-copper alloys are made from an alloy containing approximately 92 per cent aluminum and 8 per cent copper. Among the other alloys used for commercial castings are those containing from 2 to 13.5 per cent copper, the remainder being aluminum. The 96–4 aluminum-copper alloy is used extensively for sand-cast cooking utensils. In this country a favorite motor-piston alloy is made with from 9 to 10.5 per cent copper and the remainder aluminum, but some plants introduce iron as well as copper to increase the hardness. The consensus of opinion among foundrymen seems to be that the 92–8 aluminum-copper alloy is the best available for general casting purposes.

FIBER BENDING AND FORMING

Fiber should always be bent parallel to the grain (the long way of the sheet), because it is difficult to bend fiber across the grain without breaking it. The general practice is to soften the material (more or less) by immersing it in hot or cold water until sufficiently tempered, and then drying it in heated forms under enough pressure to keep the shape desired. The fiber should be left in the heated forms long enough so that it will retain the desired shape after cooling. However, heated forms are not always necessary. If the material can be steamed, instead of immersed, it will require less time to set. Angles can be bent in bending brakes fitted with electric gas, or steam heat. Special pieces can be formed on a hot plate in cast-iron forms, under pressure of a hand-operated spring plunger. In making up the top and bottom forms, some allowance should be made for the fact that fiber swells slightly when it is soaked or steamed. Tubes can be bent by softening in hot water, filling with sand, and clamping in wooden or metal forms, after which it is necessary to dry them at about 150 degrees F.

PARAMAGNETIC SUBSTANCE

If a substance has a magnetic permeability greater than that of air, it is called a paramagnetic substance. Most substances are very slightly paramagnetic, but the only substances that are strongly paramagnetic, that is, that have a permeability considerably greater than that of air, are iron, steel, nickel, and cobalt, and certain of their alloys. A paramagnetic substance is the opposite of a diamagnetic substance, which latter has a permeability less than that of air. The only know substance that is diamagnetic in a measurable degree is bismuth. All the elements except iron, steel, nickel, cobalt, and bismuth are generally considered to be non-magnetic.

What MACHINERY'S Readers Think

on Subjects of General Interest in the Mechanical Field

SHAPERS FOR PRODUCTION WORK

Shapers have usually been considered in terms of length of stroke, but it is frequently misleading to consider the length of stroke as the one determining factor in the selection of a shaper. While the length of stroke affects, in a measure, the general dimensions of a shaper, the proportions of the machine in regard to the size of ways, strength of the various parts, gearing, etc., are determined by the size of cuts to be taken and the class of work for which the machine is to be used. There are instances where the full stroke of a shaper is used, but these are quite the exception.

The shaper is being used considerably more on production work than formerly, particularly when the lots are small. It is capable of handling a great variety of work, and at the same time may be used to advantage on that class of production work where comparatively small quantities of similar pieces are required. The initial cost of the machine is much less than that of highly productive machines, and as the tooling and cutting tools are of the most simple form, the machine effects great savings. The actual time required to finish a given piece may be a few minutes longer with a shaper, but when the total cost is computed, it will be found that labor, investment, tooling equipment, etc., cost so much less on a shaper that a large saving results.

C. L. CAMERON

THE IMPORTANCE OF DELIVERY

It is bad practice to give a definite promise of delivery, when it is known that the promise cannot be kept. This gives the firm a bad name, and repeat orders are frequently lost. If it is the policy of the firm to hold completed units in stock ready for despatch, a large enough stock should be maintained to meet all demands, and a little over. The customer who places an order upon the understanding that immediate shipment will be made, is not pleased to learn that a week or a fortnight must elapse before his purchase is received.

If the unit has to be subjected to further operations after the receipt of a definite order, this fact should be made known to the customer, or at all events he should not be led to believe that the goods can be despatched immediately upon receipt of his order. In certain cases, the additional work cannot be undertaken until the precise requirements of the customer are known, as, for example, the length of chain required for a hoist, or the width of the joist for an overhead traveler, etc. The firm should keep all the essentials in stock, assembled together as far as practicable, so that, upon receipt of the order, the unit can be gotten ready for shipment in two or three days.

When the unit has to be built to the customer's specification, delivery is usually of primary importance, and no matter what circumstances may exist in the factory, every effort should be made to deliver in accordance with the promise. When there are few orders on the books, there is often a tendency to "go slow," and it is well known that it is more difficult to get orders completed on time during a slack period than when the factory is working at full pressure. This is because facilities are curtailed, the number of workers reduced to the lowest limit, and the few orders in progress are handled with a view to keeping the men going for the longest possible period.

The customer does not appreciate this, for he expects his order to have every attention, and not be utilized as a convenience. The management must work, not upon the assumption that when the order is completed there will be nothing to take its place, but with the expectation of further orders as a result of expeditious handling. The moral is, "Don't undertake what you cannot perform." If you give a promise, stick to it, no matter what may be the cost—it will be worth it. Be straight with the customer on the question of delivery, and it will prove a paying proposition.

W. J. HISCOX

CONFLICTING AUTHORITY IN FACTORIES

Many chief executives feel that their position permits them to issue orders to anybody in the plant—generally to the man nearest at hand. This is a practice destructive of discipline. In order to maintain discipline, orders and instructions should pass through clearly defined channels, and if a high official finds it necessary to stop the progress of work or to issue new instructions, he should do this through the man in charge. Men lose respect for their foreman when they find that they must listen to orders from other sources; it weakens the hold of the foreman on his men, and it often places the men themselves in a difficult position.

In one factory where the general manager had this weakness, the men learned by experience to listen to him when he issued instructions, but to go ahead as instructed by their own foreman—telling the latter when he came their way exactly what had transpired. Invariably it was found that the general manager forgot the instructions he had issued. It is surprising how the rank and file of an organization, as well as the foremen, size up the peculiarities of an executive and let this knowledge govern their actions.

In any organization that is to function properly, respect must be maintained from top to bottom, and where there is conflict of authority, respect cannot be maintained. Both the shop men and the foremen respect the executive who recognizes the rights of others. If the superintendent sees work being done in a wrong way, he should take the matter up with the foreman. Both the shop men and the foremen like to have instructions come through the regular channels, and the foreman, knowing his duties and that his actions cannot be questioned by anyone except his immediate superior, will develop a greater sense of responsibility. J. S. G.

MOISTURE IN COMPRESSED AIR

The article entitled "Moisture in Compressed Air" in the October number, page 125, carried a message on a subject that probably few realize the importance of, unless the moisture actually gives them trouble. In our plant, we compress about 175,000,000 cubic feet of air to 30 pounds pressure each month. We have recently installed an aftercooler through which about two-thirds of the air passes before reaching the receiver. From this aftercooler we trap away between two and three barrels of water daily, the amount varying with the humidity in the atmosphere. If the average is, say, 125 gallons per day, it would amount to 3750 gallons per month. We are located 900 feet above sea level in what is generally regarded as a reasonably dry atmosphere. There must be many places where water is present in much larger quantities.

The result of this installation has been that we get cleaner air and pipe lines, for oil as well as water is trapped away, and we do not need to bleed the drips in various parts of the piping system nearly so frequently as before. A. E. WINDLE

Moment of Inertia of Irregular Sections

By WILLIAM W. JOHNSON

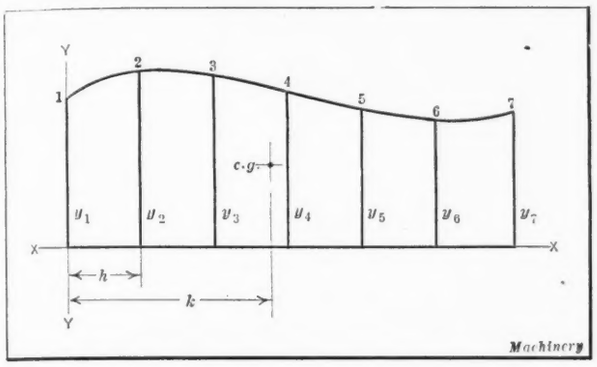


Fig. 1. Irregular Section, the Area of which may be found by applying Simpson's Rule

TO determine the moment of inertia of irregular sections is usually a long and tedious process, and any procedure tending to make problems of this kind less formidable should be of value. The method to be described depends upon finding the area included between straight lines and an irregular curve, as shown in Fig. 1. The area under the curve can be found only approximately, since the curve is irregular and does not follow any mathematical law.

For finding the area of this section the writer has chosen Simpson's one-third rule, as it is the easiest to apply and is generally more accurate than any of the other formulas for finding areas approximately. Its accuracy depends on how close the ordinates y_1, etc., are spaced. (Simpson's rule is described in MACHINERY'S "Draftsman's Mathematical Manual," page 232).

By Simpson's rule the formula for the area is:

$$A = \frac{h}{3}(y_1 + 4y_2 + 2y_3 + 4y_4 + 2y_5 + \ldots + 4y_n + y_{n+1})$$

in which y_1 and y_{n+1} are the lengths of the extreme ordinates; y_2, y_3, . . . y_n are the lengths of the intermediate ordinates; n is the number of equal intervals between the ordinates (n may be any even number); and h is the distance between consecutive ordinates.

Table 1 shows the method of finding the moment of inertia of a given area about an axis through its center of gravity, by using Simpson's one-third rule. Since the location of the center of gravity is unknown, this has to be determined first by taking moments about an assumed axis. It will be assumed that ordinate No. 1 is the axis, and k is the distance from this axis to a parallel line passing through the center of gravity as shown in Fig. 1.

TABLE 1. METHOD OF FINDING THE MOMENT OF INERTIA OF AN IRREGULAR SECTION ABOUT AN AXIS THROUGH ITS CENTER OF GRAVITY

Ordinate Number	Length of Ordinate	Simpson's Multipliers	Functions for Areas	Moment of Arms about Assumed Axis (Multiples of h)	Functions for Moments	Functions for Moments of Inertia
N	y	m	m × y	x	x × my	x × xmy
1	y_1	1	y_1	0	0	0
2	y_2	4	$4y_2$	1	$4y_2$	$4y_2$
3	y_3	2	$2y_3$	2	$4y_3$	$8y_3$
4	y_4	4	$4y_4$	3	$12y_4$	$36y_4$
5	y_5	2	$2y_5$	4	$8y_5$	$32y_5$
6	y_6	4	$4y_6$	5	$20y_6$	$100y_6$
7	y_7	1	y_7	6	$6y_7$	$36y_7$
Total.....			B		M	I

$$k = \frac{M}{B}h \text{ (1)} \quad A = B\frac{h}{3} \text{ (2)} \quad I_{cg} = \left(I - \frac{h^2}{3}\right) - Ak^2 \text{ (3)}$$

Machinery

To find the center of gravity, the area, and the moment of inertia of the section with respect to an axis passing through the center of gravity, we must first divide the area into an even number of equal parts, as shown, and find the values for y, etc., by measuring the ordinates. The values tabulated in the first three columns of Table 1 can then be determined from the formula for A already given. The other values in the table are next easily found from those tabulated in the first three columns. Adding the numerical values of the tabulated functions, we obtain numerical values for B, M and I. Substituting these values in Formulas (1), (2), and (3), we find the center of gravity, the area, and the moment of inertia of the section with respect to an axis passing through the center of gravity.

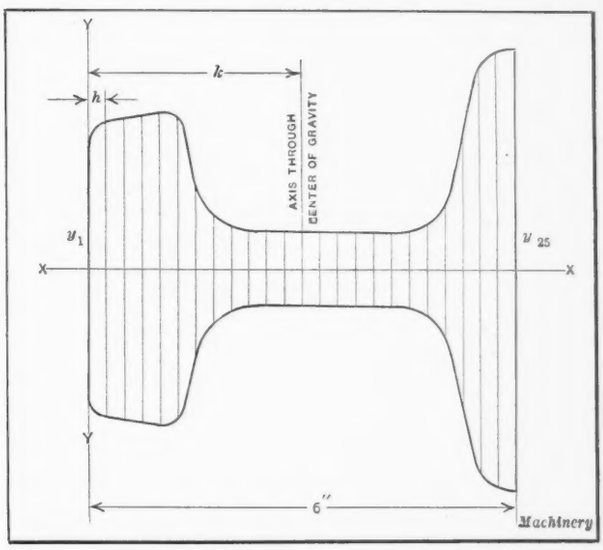


Fig. 2. T-rail Section of which the Area, Center of Gravity, and Moment of Inertia are to be determined

Calculating a Typical Section

In order to illustrate the method of procedure outlined, let it be required to find the area, center of gravity, and moment of inertia of the standard T-rail section No. 539 given in the Cambria "Steel Handbook." It is necessary that we have an accurate drawing of the section to scale, and then divide the section into an even number of equal parts by an odd number of ordinates, as shown in Fig. 2. In this case $n = 24$ and $h = 1/4$ inch. The lengths of the ordinates on each side of the X–X axis are first measured to find the values to be inserted in the second column of Table 2, which is constructed similarly to Table 1. The other values in this table can then be easily computed.

Then by Formula (1) given in Table 1,

$$k = \frac{M}{B}h = \frac{2105.72}{176.8 \times 4} = 2.977 \text{ inches}$$

By Formula (2),

$$A = B\frac{h}{3} = \frac{176.8}{3 \times 4} = 14.73 \text{ square inches}$$

TABLE 2. CALCULATIONS FOR FINDING THE AREA, CENTER OF GRAVITY AND MOMENT OF INERTIA OF A T-RAIL

N	y	m	my	x	mxy	mx^2y
1	3.50	1	3.50	0	0.00	0.00
2	4.00	4	16.00	1	16.00	16.00
3	4.10	2	8.20	2	16.40	32.80
4	4.17	4	16.68	3	50.04	150.12
5	4.23	2	8.46	4	33.84	135.36
6	4.15	4	16.60	5	83.00	415.00
7	2.35	2	4.70	6	28.20	169.20
8	1.46	4	5.84	7	40.88	286.16
9	1.14	2	2.28	8	18.24	145.92
10	1.00	4	4.00	9	36.00	324.00
11	1.00	2	2.00	10	20.00	200.00
12	1.00	4	4.00	11	44.00	484.00
13	1.00	2	2.00	12	24.00	288.00
14	1.00	4	4.00	13	52.00	676.00
15	1.00	2	2.00	14	28.00	392.00
16	1.00	4	4.00	15	60.00	900.00
17	1.00	2	2.00	16	32.00	512.00
18	1.00	4	4.00	17	68.00	1156.00
19	1.00	2	2.00	18	36.00	648.00
20	1.22	4	4.88	19	92.72	1761.68
21	1.75	2	3.50	20	70.00	1400.00
22	3.75	4	15.00	21	315.00	6615.00
23	5.64	2	11.28	22	248.16	5459.52
24	5.97	4	23.88	23	549.24	12632.52
25	6.00	1	6.00	24	144.00	3456.00
Total.....			$B = 176.80$		$M = 2105.72$	$I = 38,255.28$

Machinery

By Formula (3),

$$I_{cg} = \left(I \times \frac{h^3}{3}\right) - Ak^2 = \frac{38255.3}{64 \times 3} - \frac{176.8\ (2105.72)^2}{12\ (176.8 \times 4)^2}$$

$$= 199.25 - 130.57 = 68.68 \text{ biquadratic inches}$$

In the handbook of the Cambria Steel Co., the value is given as 69.3 biquadratic inches.

The present article does not contain any principles that are not well known in mechanics, but combines the method for finding the center of gravity, and computing the area and moment of inertia of any irregular section into one clear and concise method of computation.

* * *

MILLING MOTOR-BOAT CONNECTING-RODS

In building motor-boat engines at the plant of the Sterling Engine Co., Buffalo, N. Y., certain problems are met that are not common in building automobile engines or machines in large quantities. For instance, while all parts for a given lot of engines must fit interchangeably, the number of engines in the lot usually does not warrant the making of many special work-holding fixtures for the various operations. Most parts must be finished accurately, because the engines are frequently made to run at 2000 or 2500 revolutions per minute, and with inaccurate parts, such high speeds would be impossible. Engines up to 300 horsepower capacity are built in this plant.

The accompanying illustration shows a typical operation in which work-holding fixtures are dispensed with. The operation consists of milling both bosses on the large end of steel connecting-rod forgings. It is satisfactorily accomplished by laying the connecting-rods directly on the table of a planer-type milling machine, and feeding them past two cutters mounted on vertical heads. The rough-forged hole in the large end of each rod is placed over a T-bolt that extends from the slot in the table. A taper plug is slipped over this T-bolt to seat in the hole of the rod, after which a nut is tightened on the plate to clamp the rod securely in place. The wrist-pin end of the rods is left free, but as the rods are spaced alternately with the large end on the right-hand side of the table and then on the left-hand side, and as a clamp backs up the wrist-pin end of the last rod, there is no tendency for the rods to shift.

When a cut has been taken across the entire length of rods, they are unclamped, turned over and reclamped, after which the opposite side of the large end is milled. The tolerance on the width of the large end is 0.003 inch. In the particular operation illustrated, fifty rods were placed on the table at one time.

Connecting-rods laid flat on the **Machine Table for milling the Crankshaft End**

* * *

It has been estimated that 10 per cent of the machine tools used in Great Britain are of American manufacture. This statement is made by Assistant Trade Commissioner W. M. Parks of the Department of Commerce. In some lines of production, for example in the automobile and electrical industries, the percentage would be much higher, perhaps up to 20 or 30 per cent. This is particularly interesting and significant when it is remembered that the manufacture of machine tools is an old and well established domestic British industry and that American machines must compete with the highly developed and carefully organized home industry. At the present time the United Kingdom is the best customer of the United States for metal-working machinery, the value for the first six months of 1925 being over $2,000,000, as against $1,560,000 for the same period in 1924. An inquiry into the types of American machine tools which are mostly in demand in the British market shows that special grinding machines, gear-cutting machines, multiple drilling machines, and special lathes for crankshaft turning, as well as lathes taking several cuts at the same time, are now having the best sales.

* * *

The welding together of the frames for jigs and fixtures from plates and structural steel shapes is being successfully done by the General Electric Co. In this way the expensive pattern necessary for making a single casting is avoided. Many times the completed jig costs less than the pattern alone, and in addition to the saving in cost, the method of welding jig and fixture frames together saves a great deal of time, as compared with the making of a pattern and a casting.

Successful Industrial Management

By J. SETON GRAY

THE final gage by which the success of an industrial undertaking must be measured is whether or not it prospers financially. Regardless of the efforts on the part of an employer and his organization, the quality of the work done, or the progress in industrial development for which the factory may be responsible, if it is not a financial success, then the undertaking, looked upon as a commercial unit, is a failure.

It is important that the entire organization should have some idea about the position of a factory as a business venture. Many employers hesitate to give their employes too much information in this respect, believing that the information may reach people who may use it to their own advantage. It is believed that what may be lost in this direction is amply gained through the value of the cooperative spirit that can be built up within the organization by frank and free distribution of information. If an organization knows where it is heading, it will work to better advantage than if the employes are in ignorance of the actual facts.

If a business is having difficulty in keeping its head above water, a loyal organization will exert itself to save the situation, when properly informed about it; and when the conditions are improving, let the factory organization know this. Nothing destroys confidence more than the suspicion that the management is keeping the employes in ignorance of the actual conditions, with some ulterior motive in view. Frankness on the part of the employer breeds frankness on the part of the employe, and this creates an atmosphere of mutual understanding, appreciation, and honesty that will work wonders for any organization.

Generally speaking, those organizations have been most successful in which the employer has clearly defined his purposes and based his policy on square dealing, so that all the employes feel that they are to some extent partners in the undertaking, and that success for the employer means success for them. This is the only way in which real cooperation can be inspired in an organization and continued success insured for any industrial undertaking.

The Management Must Watch Costs

Every manager must endeavor to produce as much of his product as he can, of a given quality, at as low a cost as possible. This is one of the first principles of successful industrial management; but this does not mean that wages must be cut to a minimum, because successful managers recognize that the higher the wages paid, provided they are earned by the men, the better it is for both parties.

An industrial undertaking purchases labor on the same basis as every other commodity, and must try to obtain the greatest returns on the investment; but the wise employer knows that the best results can only be obtained when the men feel that a fair bargain has been made. This means that the men must be earning, in any particular factory, as much as they would earn elsewhere, and the conditions in the factory must be as congenial as elsewhere. Men who realize that they are paid a fair compensation for their efforts remain longer, and the great waste due to labor turnover is reduced.

Lack of Information is the Cause of Much Dissatisfaction

Many employes believe that the management is constantly devising means for keeping wages down, and they would be surprised to learn that most successful managers are not so much interested in reducing wages as in reducing costs. The employes often do not realize that there are other items besides labor costs that enter to an even greater extent into the total cost of the manufactured article. In some industries, a 5 per cent saving on materials would amount to more than a 20 per cent reduction in wages.

If the employer would take more pains to see that everyone connected with the organization understands the cost of the items that enter into the final price of the article manufactured, he would do a great deal to prevent unfavorable criticism in the shop. The average shop man is not familiar with costs, and when he hears that there is an effort to reduce costs, he thinks that it can be done only by cutting wages, overlooking the fact that materials, supplies, power, and many other items generally amount to more than the total labor charges, and that the savings on these items are those in which the employer is chiefly interested. In his efforts to save these costs, the manager can be greatly assisted by his employes if he takes them into his confidence and obtains their cooperation.

The Foreman's Place in the Organization

It is a wise employer who realizes that the foremen are the true representatives of the management in the factory and that whatever the foreman says or does will be considered as the opinions and acts of the management. The management develops the processes and furnishes the tools and material with which to do the work, but it is the foreman who sees that the ideas are carried out. It is the management that pays the workers, but it is the foreman who sees that a fair day's work is given for the compensation received.

Whether inside or outside of the factory, men do not like to see changes take place unless they are in some way identified with the changes. An employer, recognizing this trait in human nature, will take his foremen and, through them, the entire organization into his confidence and let them know what he is planning to accomplish. If the interest of the men can be aroused in a new method, it can be introduced more smoothly than if the method is forced on the men without explanation. There is nothing more disheartening to a man than to be given work without having any idea what results are aimed at.

Encouraging Loyalty and Cooperation

Inspiring loyalty should be the goal of every employer, as big things can only be accomplished by the united efforts of many men. One man may accomplish a great deal alone, but if he has the faculty of inspiring other men to work with him, his own efforts are multiplied many times. There are factories where this spirit of cooperation has been developed to such an extent that even the sweepers think about their jobs as being something of importance, and realize that the cleanliness of the factory is one of the important means by which it is kept running efficiently.

The employer must see that he can depend upon his foremen to interpret his ideas so that every foreman will think and act, as nearly as possible, as the manager himself would under like circumstances. Only when this condition exists can the manager feel satisfied that the men in his employ are all given a square deal. The employer should also see that all suggestions coming from his foremen or from the men are given some recognition, and for such suggestions as are of value some suitable reward should be made. In different plants such rewards are taking different forms, such as vacations, increased pay, or prizes. Where the sav-

ing due to the suggestion can be definitely ascertained, a certain percentage of the saving for a given time might be used as the reward. The main thing is that suggestions are encouraged, fairly considered, and, if deemed of value, at least tried out.

The All-important Matter of Wages

The rate of pay, in many cases, is arrived at in a very haphazard way. This is due to the difficulty of accurately estimating a man's value to the firm when he is paid on a fixed hourly basis. When the character of the work permits, it is becoming more and more the custom to pay men for the quality and quantity of the work turned out, rather than for the time that they spend in the shop. To pay in proportion to results is, of course, the only fair way, to both men and management. Because of the importance of this fact, employers are gradually beginning to realize the true value of time studies.

Materials are bought and paid for in accordance with specifications, and in buying labor it is only right that it be paid for in accordance with similar specifications. The man whose quality and quantity of work comes up to the specifications is entitled to more compensation than the man whose labor does not meet these requirements. Whenever any new systems of compensation are installed, however, the method should be clearly explained to the employes, and it should be made clear to them that the object is to establish a fairer basis for compensation.

It is becoming more and more appreciated that to get the best results out of a man his working surroundings must be congenial. A man, to do his best work, must feel happy and contented at his work.

Close Contact with the Working Force is of Great Value

An employer should realize that in order to obtain the whole-hearted cooperation of his organization, he must see and talk to that organization from time to time. The average man cannot develop real loyalty to an employer whom he has never seen or never heard express himself. Many employers find it difficult to express themselves before a crowd, not because they cannot do it, but because instead of acting natural and stating the facts as they would in an ordinary conversation, they seem to feel called upon to make a speech.

If they would get their factory organization together from time to time and tell them something about the conditions of the business, what they hope to accomplish, the difficulties they are encountering, and how everyone might help, there would be more of a cooperative spirit in the plant. Men like to know what is expected of them, and it creates a friendly feeling and a wholesome atmosphere when the big boss, so to speak, puts his feet under the table with them. When the feeling prevails that "the boss is one of ourselves," real results may be expected.

Rules and Regulations Around the Factory

Where there is real management, there are very few rules. The employer feels that the average man in his employ knows what is the right thing to do and does not have to be told what not to do. Experience has proved that friendly feelings are not encouraged when the employes receive written instructions from time to time, stating that this or that is strictly forbidden. The employer should draw attention to conditions that are wrong and show why they are wrong, and then leave the remedy to the good sense of the employes. In most cases this method will be found to work much better than the other. The little sign "Please" has kept a great many more feet off a freshly sodded plot of grass than the sign "Keep Off."

The mere position of authority that he occupies makes the wise employer consider the right of others. It is all very well to be in a position of dictating to others, but no man can be the whole orchestra himself. He can only direct the orchestra, and every musician is in a position to create discord should he choose to do so. No undertaking can long be expected to succeed if discord prevails.

Most men respond more readily to courteous treatment than to threats. The organization based upon courtesy and mutual respect from top to bottom, other things being equal, will succeed the best.

Avoiding the Great Cost of Labor Turnover

As a rule, no employer wishes to discharge a man unless there is no other course open. It costs money to hire new men and to break them in. The man that belongs to the organization knows a great deal more about the work than a new man will for some time to come. Care should be taken in discharging men to prevent erroneous conceptions from being formed. The reputation of the factory is of value not only among its customers, but among the workers in the vicinity. If a factory gets the reputation of being a mean place in which to work, the best and most skilled men will keep away from it, and it will ultimately have either to pay very much higher wages than other shops to get men, or be satisfied with the quality of men that other plants do not want.

Importance of Understudies

To insure that the organization will function at all times, understudies must be trained for the men who hold important positions. It makes no difference what position a man holds, some day he may not be there, and the factory must function just the same. To prepare men so that they can perform the work of others always requires expenditure of time and money, but this is a form of insurance to keep the factory operating steadily. Many men object to training somebody else to fill their place, overlooking the fact that in so doing they often prepare the way for themselves to fill a better position. A foreman who objects to training one of his men so that he can temporarily fill his place is not working in the best interests of the organization. Part of his job should be to teach his men, and particularly someone capable of filling his place, as much as he can about the business.

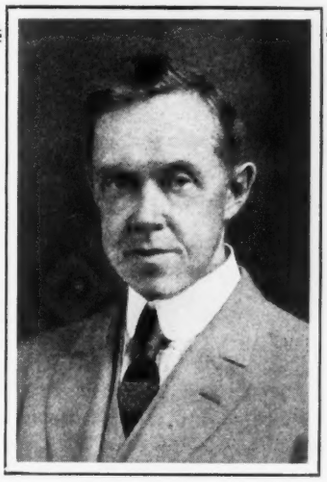
The Need of Accurate Records

The carrying of excessive stocks is a fertile field for increased costs. Excessive stock may be either in the form of raw material purchased at bargain prices, or partly finished products produced in quantity in order to save production costs. The carrying charges for this material or for the parts may, however, be much greater than the savings realized by buying it at a low price or producing it at a reduced cost. This subject requires a mathematical study, and only by calculations can the right amount of stock to be carried, or the number of pieces to be produced economically at one set-up, be determined.

Simple, but definite and clear, records are necessary if a management wants to know its costs and to find ways and means of reducing them and simplifying production methods. Such records should also show the percentage of capacity to which the factory is working. In a certain machine shop, at one time, there was a rush of work for the boring mills. It appeared as though more equipment had to be installed to take care of the work. A number of recording meters were placed in the circuits furnishing power to these machines, and it was found that the actual running time of the boring mills was only 45 per cent of the total. By taking care that material was brought to these machines promptly, that proper crane service was furnished, and properly sharpened tools supplied to the operators, the running time of the boring mills was increased to 68 per cent, which eliminated the need for new equipment. Without actual records covering factory operations, no manager can expect to control costs intelligently. Whenever possible, the results obtained from the records should be freely given to the organization.

Dividing Head Designed for Heavy Work

By O. S. MARSHALL



OSCAR S. MARSHALL was born in Cornwall, Vt., in 1870. He served an apprenticeship with Gilman & Son, Springfield, Vt., and obtained his mechanical education as a special student at the Syracuse University and through the American School of Correspondence. For ten years he was with Gilman & Son, five of which he served as shop superintendent. He has been with the Jones & Lamson Machine Co., Springfield, Vt., for eighteen years, holding different positions, including that of foreman of the planing and grinding departments and of special equipment work. He has also had considerable experience on experimental work. He specializes on tools, jigs, and tooling equipment, and has been a frequent contributor to the technical press.

IN the accompanying illustrations is shown a new type of dividing head designed to cover a wider range of precision indexing and to handle heavier work than the ordinary type. Although the new dividing head is adequate for very heavy work, it can be used equally well for any of the lighter and more delicate operations encountered in precision work.

The universal attachments now provided for all standard makes of milling machines practically eliminate the need for a tilting dividing head, except possibly for cam work. Therefore, the dividing head here illustrated is provided with a swivel-base, the idea being to use a universal attachment for obtaining angular positions. The chuck fitted to the dividing head has a capacity for gripping work 12 inches in diameter, and has a 4 1/4-inch hole through the work-spindle, and a full-circle swivel-base with vernier graduations reading to 10 minutes.

Special Indexing Mechanism

For precision indexing, a second worm *A* and indexing plate *B*, Fig. 1, is provided, which actuates the main index-plate *C*. The pitch diameter of the worm-wheel, the teeth of which are cut in the periphery of plate *C*, is 9.549 inches. There are 360 teeth in this worm-wheel, which meshes with a worm 1 inch in diameter. The main worm-wheel *D*, Fig. 3, has a pitch diameter of 8.486 inches, and is driven by a worm 3 inches in diameter, giving a ratio of 40 to 1. The secondary indexing plate *B* is provided with 90 spacing holes. This index-plate makes it possible to index directly in either degrees, minutes, or seconds without making computations of any kind. There are no intermediate gears, and both the secondary worm and the main worm are manipulated directly from their respective cranks which are mounted on the worm-shafts. This eliminates lost motion or backlash. It will be noted that the various parts of the dividing head are designated by the same reference letters in all the illustrations.

Each worm-shaft has ball thrust bearings, and the work-spindle will remain fixed or rigid without tightening the spindle clamping nuts. The main worm-spindle bearings and the thrust bearings are provided with suitable mountings, and will resist, without distortion, the heaviest cutting strains imposed upon these members. The chuck and other spindle attachments are held to the spindle by a series of bolts *E*, Fig. 3, and are located by a dowel-pin and a projection of the spindle center, which is a light drive fit in the fixture or chuck.

Referring to Figs. 1 and 2, it will be noted that objectionable overhang of the chuck has been eliminated in designing the body of the dividing head and that there is ample working space, particularly when the dividing head is set crosswise on the platen. The front end of the work-spindle is practically in line with the vertical axis of the swiveling base. Thus, with the 12-inch head shown, there is from 2 to 4 inches more working room on the machine than with the standard heads using 9-inch chucks.

Every precaution was taken to obtain extreme accuracy when making the indexing head. The main worm-wheel is made from two disks, the sections of which were bolted to-

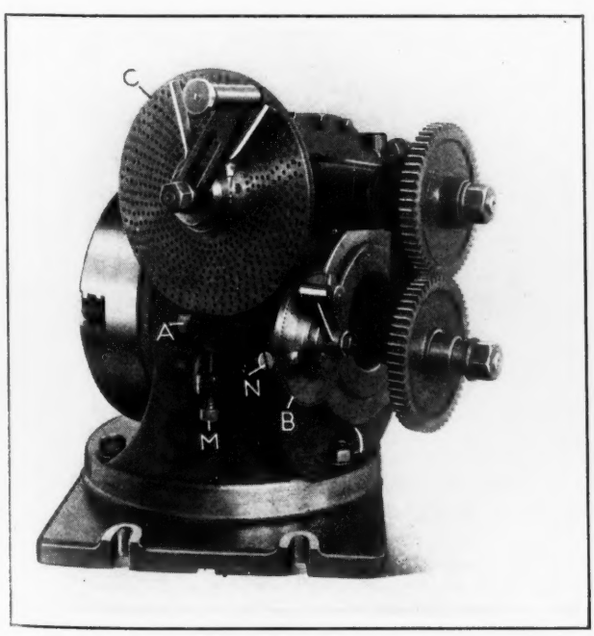


Fig. 1. Precision Dividing Head equipped with Chuck

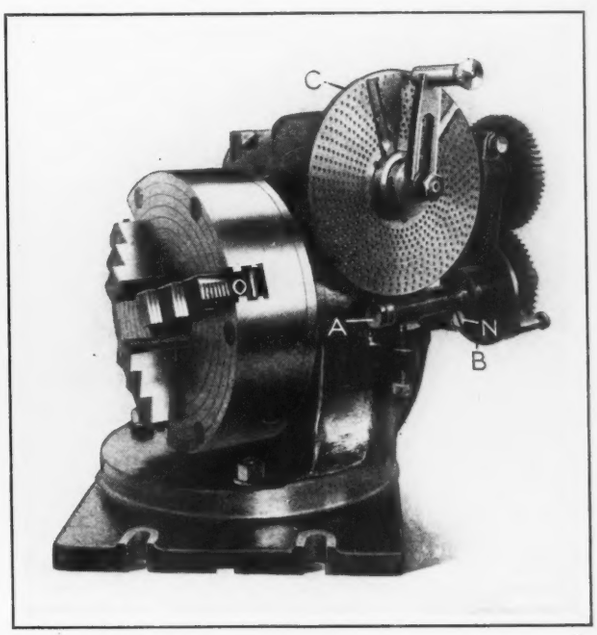


Fig. 2. Chuck Side of Dividing Head shown in Fig. 1

gether and carefully hobbed on a hobbing machine that was in very good condition. The disks were then lapped several times, the two halves being set around after each lapping operation until practically all measurable errors were eliminated.

In order that the spindle of the dividing head may be driven from a power feed-shaft for such operations as spiral milling, a bevel gear *P*, Fig. 3, is mounted on the worm-shaft of index-plate *C*, which meshes with a bevel gear *F*. On shaft *G* is mounted a gear *H*. The gears *H* and *J* form part of a train which derives motion from any feed-shaft. The change-gear for the dividing head is applied to the hub that projects from the right-hand side of gear *J*. The gears *H* and *J* have the same number of teeth. Gear *J* is supported on the swinging arm *K*, thereby permitting the stud that carries gear *J* to be brought to the regular dividing head change-gear position. This is necessitated by the increased height of the new head, and enables the standard change-gear chart to be used no matter what make of milling machine is employed.

The screw *M*, Fig. 1, may be adjusted to obtain proper meshing of the worm with the teeth cut in the periphery of plate *C*. The bracket that supports worm *A* is pivoted on stud *N* to permit disengagement of the worm from the worm-wheel when the head is geared to the milling machine for spiral work. Five dividing heads of the design shown have been made, and all are now in use. They have been subjected to every kind of working condition, both on heavy and light work of extreme accuracy.

The indexing mechanism described is fully protected by the writer with letters patent dated December 11, 1923, bearing the number 1,477,374. The main head design claims are subject to a separate patent, which is now under way.

The writer has not yet placed the dividing heads on the market, and those who would like to obtain the patent privilege for their own use may do so by simply notifying the writer of their desire. This privilege also applies to the main head features. The privilege of manufacturing the heads for the trade will not, of course, be granted. The larger patterns and copies of the blueprints can be supplied if desired.

* * *

In cases where armature or other shafts have become worn at the journal they can often be built up and saved by electric arc welding.

WIRE ROPE LUBRICATION

The following information on the lubrication of wire rope is taken from the United States Government specifications for wire rope: Wear of a running wire rope occurs where the outside wires come into contact with the sheaves and drums, especially if slipping takes place, and, also, where the wires are in contact. During the fabrication of a wire rope, the fiber core is saturated with lubricating compound, which in service is gradually supplied to the wires and reduces the wear on them. As the core will not carry enough lubricant for the life of the rope, it is necessary occasionally to apply a lubricant to the outside of the rope, which will be absorbed by the core. A mixture of a heavy-bodied lubricant and a good grade of graphite is as satisfactory as any of the proprietary lubricants, and is cheaper. A viscous preparation which remains on the outside of the rope does not lubricate the inner wires of the rope.

For elevator cables, any lubricant containing an opaque substance is undesirable, as it interferes with the proper inspection of the rope by making it difficult to detect broken wires. Graphite and similar lubricants may cause excessive sliding of cables on traction-drive elevators, and should not be used on this type of equipment. Boiled linseed oil, applied hot, will saturate the hemp center and will give a transparent covering when dry that will not interfere with the thorough inspection of the rope. If an uncoated wire rope is to be used where it is likely to corrode, the lubricant should have a very heavy body and be applied to the rope so hot that it will penetrate to the core.

* * *

The oldest stock company in the world is the Stora Kopparbergs Bergslags A. B., in Sweden, which this year celebrates its 700-year anniversary in business. This company has been continuously engaged in iron and copper mining for seven centuries, and inasmuch as in the early days all the Swedish iron was charcoal iron, it also engaged in the lumber business and in forestry, which is still being carried on. It is stated that the forest lands of the company are today yielding more than at any previous time. Through scientific methods of forestry, the timber holdings are worked on a continuous yield basis, much the same as a farmer plants and harvests his corn. Every seventy or eighty years the lumber-jacks turn to the same timber tracts for cutting, and the so-called cut-over forest problem does not exist.

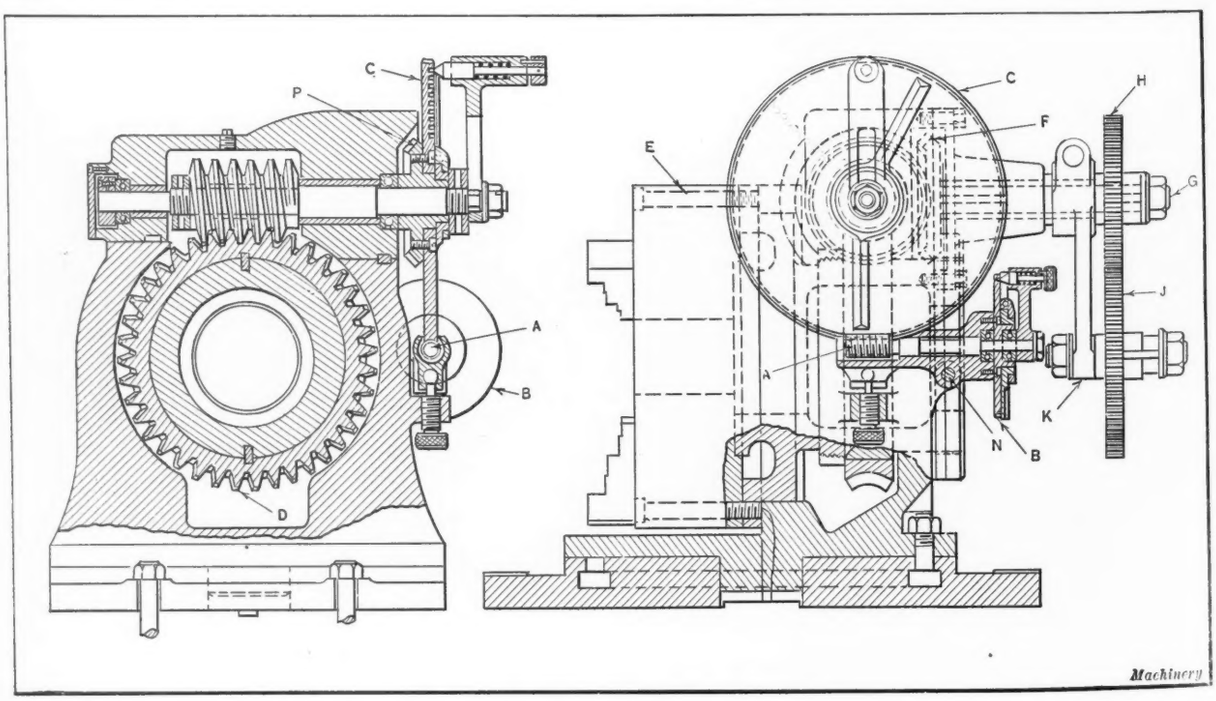
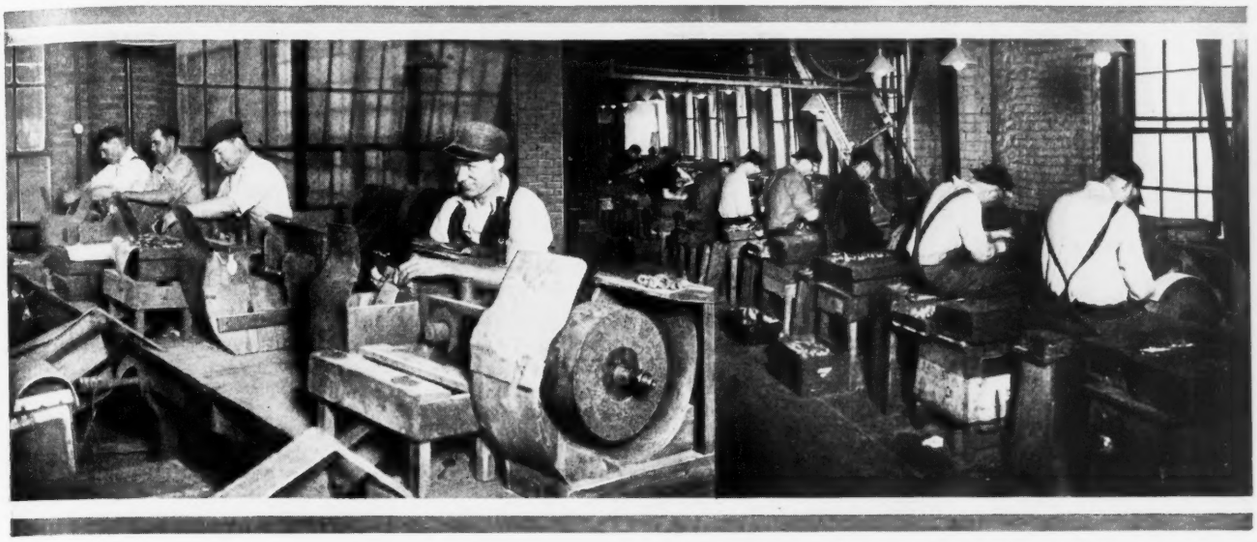


Fig. 3. Sectional Views of Precision Dividing Head shown in Figs. 1 and 2



Metal Polishing Methods

THE lack of standardized methods in metal polishing and the absence of a uniform type of equipment are plainly evident to those who have observed some of the practices of different polishing rooms. It is quite difficult to classify the information on modern polishing practice obtained by such observation and to present it with the degree of definiteness that it should have to be of the most use. Polishing, including flexible grinding, covers a wide range of work extending from the rougher classes, such as the removal of scale from forgings, to the production of the highest degree of luster required for certain grades of hardware and cutlery.

Operations for Obtaining High Luster

When compress wheels are employed, four operations are generally sufficient to obtain the highest luster on a surface. These are: (1) Flexible grinding, with coarse abrasive, generally around No. 46; (2) dry-fining, with an abrasive between, say, Nos. 80 and 120; (3) greasing (so called because tallow and wax compositions are applied to the wheel), with abrasives from Nos. 120 to 180; and (4) coloring, which employs the finest abrasives up to FF and a coloring composition, such as crocus cake.

The number of these operations may, however, be varied to suit the quality of finish desired. For example, surgical instruments and other high-grade plated articles require two greasing operations (the second of which employs a finer abrasive than the first), to obtain the necessary quality of surface. These are followed by the regular finishing or coloring operation. When polishing wheels other than compress wheels are used, the roughing operations are generally performed on solid grinding wheels, and the wavy nature of the surface produced affects the entire polishing procedure, so that more than four operations are usually required.

Polishing Operations for Cutlery

For cutlery finishing, the roughing operations are generally performed on solid grinding wheels, and these are followed by what is known as a "rough-glazing" operation, which is similar to the dry-fining operation previously mentioned, and a finish- or fine-glazing operation, which is really a greasing operation employing a tallow or wax on the wheel. Although the terms used in the cutlery industry are not the same as those generally employed in the polishing trade, these operations are intended to produce the same results as the four operations previously mentioned. Unplated cutlery, like pocket-knife blades, is colored with crocus to give the final finish, but cutlery that is to be plated is polished on a greased wheel set up with flour emery or artificial abrasives, then plated, and finally buffed with a cloth buff fed with white lime or other buffing material.

Precautions for Obtaining the Desired Finish

When flexible grinding is applied to a rough casting or forging, it is advisable to start the roughing operation with the coarsest possible abrasive that will hold to the wheel, and the successive operations should each be performed with an abrasive from 25 to 40 numbers higher. For example, in the flexible grinding of a skate plate, if the first operation is performed with a No. 60 alundum, it would be advisable to follow this with a dry-fining operation using No. 100, and then a greasing operation using either a No. 120 or a No. 150 grain, coloring also with No. 150.

Changing the Direction of the Strokes Necessary for Good Finish

All polishing is done by strokes. In flexible grinding, where a number of operations are required to polish the work, the direction of the strokes should be varied. A deep scratch made with a No. 36 abrasive may be followed by a No. 60 and then by a No. 120, and if the strokes are not varied, the tendency of the abrasive of each successive wheel is to follow the contour created by the first wheel. The result is that the deeper scratches made by the coarser abrasives will not be removed. The changing of the direction of the stroke, therefore, is important, and especially so on flat work, where a high degree of luster is required.

Good polishing cannot be obtained by merely changing wheels, or by changing the speed or the abrasive, although if all other conditions are right, each of these factors has its bearing on the ultimate result. Often the design of a piece and the methods of manufacturing it must be considered when the desired finish cannot be obtained. A rather matted surface, obtained by moving the work about on the wheel face, is the ideal condition for producing the highest luster.

There is a difficulty often experienced with leather-covered wooden wheels, which is the result of what is known as burning. Burning is caused by working the wheel after the abrasive has been worn off in spots, and is a very common occurrence when using a leather-covered wheel. It is due partly to unevenness on the wheel face caused by soaking and scraping in attempting to remove the old glue and emery. When a hand tool is used to scrape off the old emery and glue, the result is that not only is the wheel-head removed, but the leather itself is gouged so that it often is impossible to properly rehead the wheel to give uniform service on the full width of the face.

Importance of Wheel Densities

In finishing a rough casting, a medium-density leather wheel, made by the compress process and charged with T-J alundum, will give satisfactory results. The leather in a medium-density wheel of this type will snap back against the work as it passes over the irregular surfaces of the work, thus repeatedly presenting new abrasive surfaces to the work. This makes a very efficient flexible wheel for general roughing operations, and may be used to advantage to replace a solid grinding wheel on work of this kind.

If a part having straight lines or curves which it is not permissible to change is to be finished by polishing, a hard-density canvas or leather wheel is suitable. For work that has fancy designs cast on its surface, a soft wheel is used which will work around the ridges and into the depressions. For this class of work, a hard wheel would be unsuitable. Cylindrical work is invariably polished with a soft wheel, using an increased speed to compensate for the small surface contact, as compared with flat work. The question of wheel density is important, because it has been observed that for the same quality of work one grade difference in wheel density will often change the entire character of the work.

Wheel Speeds

The correct wheel speeds for polishing cannot be definitely stated, because this important factor is limited by the crushing strength of the abrasive and the melting point of the glue used in holding it to the face of the wheel. If abrasive and glue permit, high peripheral speeds are an advantage for ordinary grinding or polishing. Hard sharp abrasives can, of course, be run at a higher speed than the softer ones, for mild-cutting abrasives, if subjected to high speed, will soon crush and glaze. For coloring with emery and for polishing aluminum and other soft metals, comparatively slow speeds are advisable, as a more gentle cutting action is required for these operations. The best practice is to experiment until the highest possible speed for producing good results is obtained.

The first consideration in this connection should be the character of glue and the kind of abrasives that are best adapted for the work at hand. The wheels should first be run at the speed that seems most reasonable to employ for that particular class of work; then this speed should be increased until the glazing point of the abrasive or melting point of the glue is reached, which indicates that the speed is too high. The next lower speed will probably be found to be the most satisfactory one to use.

For cutting down metal, the severity of the cutting action of the abrasive may limit the wheel speed from 3000 to 4500 feet per minute, but these speeds may be increased to as much as 9000 feet per minute, or even higher, under the most favorable conditions. The average polishing wheel speed is about 7500 feet per minute, but in setting the average speed for any particular class of work, the character of the metal being finished must be taken into consideration. It is probable that the lack of standardization in the quality of the glue used is directly responsible for the lack of a complete table of wheel speeds that may be recommended for any given class of work.

The speeds of polishing wheels are governed also by the kind of machine on which they are used, and this point is so important that one manufacturer of glazing machines has placed a rigid limit on the maximum speed recommended for these machines. This speed is 500 revolutions per minute for a 24-inch diameter wheel, regardless of whether the operation is a cutting operation or a coloring operation. A higher speed, it is stated, causes the wheels to become overheated and the head to break out.

Speeds for Buffing

On buffing wheels, the limit of peripheral speed is governed by the speed at which tripoli, crocus, or other buffing materials will adhere to the wheel; generally speaking, the speed should be as high as possible. The higher the speed used for buffing, the greater the tendency of the edges of the buff to hold up to the work (due to centrifugal action). These statements regarding buffing speed are based on the assumption that a greasy buffing composition is used rather than a dry material, because the dry material will not adhere to the face of the wheel even under moderate peripheral speeds. Buffs used for coloring purposes should be run at slower speeds than those used for cutting-down purposes.

Formed Face Wheels

A higher grade of work can be done with a polishing wheel that is shaped to fit the contour of the article than with a plain wheel, and the work can also be done cheaper. However, not very much has been done in the way of formed wheels made of solid disks, owing to the difficulty of having these wheels hold their shape. The method of making the compress wheel, however, permits formed faces to be produced which hold their shape indefinitely. The selection of suitable materials and the cushion density may be made to meet the requirements of the design and of the metal. Formed-face wheels are particularly desirable for such work as grinding the flash from forks and spoons, and other work where the outline must be carefully preserved. In order to maintain the contour, the wheel must be somewhat flexible. These wheels are usually set up with a heavy head of abrasive, sometimes as much as 1/2 inch thick.

Abrasive Friction or Cutting Power

Obtaining the proper degree of abrasive friction is necessary for good polishing. With the solid polishing wheel, this abrasive friction is difficult to obtain, on account of the varying densities of wheels of similar construction. A wheel that is too soft leaves a gray hue on the work; such a wheel also buckles, and will not cut properly. The average disk wheel which is hard enough to cut is usually too hard to produce a good finish. There is a certain point at which a polishing wheel works to best advantage, and unless this point is carefully determined, difficulties will be experienced.

If the hardness of the wheel is greater than the metal being worked on, cutting will ensue which may either grind away the metal or polish it, as the case may be; if the wheel is too soft it will simply crawl away from the metal and slide over it without cutting. The efforts of the polisher to push the work into the wheel are likely to strip the abrasive from the surface of the wheel, destroy its efficiency, and consume an excessive amount of emery and glue. Weight on the face of a polishing wheel is an advantage because it lends abrasive friction or cutting power to the wheel and relieves the operator of much of the physical exertion due to pressing the work against the wheel. Of course, where less pressure is applied to the wheel, the strain does not affect the arbor or the journal boxes of the polishing jack or stand so much, which results in a saving of power.

Cut Cakes and Coloring Cakes for Finishing Operations

When a wheel is set up with a head of fine abrasive to be used for greasing and coloring operations, the wheel is usually fed with a composition in cake form. For a greasing operation, a cut cake is used, the abrasive being of the same grain as is used on the wheel, or, at most, not more than one number finer, as, for instance, No. 150 on the wheel and No. 180 in the cut cake. The cut cake is made by adding two parts of suet or fat to one of beeswax, and when these are melted, abrasive is added until a mixture of rather thick consistency is obtained. This mixture is then poured into molds to cool.

For a coloring operation, a coloring cake is used on the wheel, the recipe for making it being varied according to whether the work is to be plated or not. When a coloring cake is used for such work as skates that are to be plated, two parts of beeswax are added to one part of suet or fat, and a finer grade of abrasive is added to this mixture than that used on the wheel. On chisels and tools that are not to be plated and that require a high-grade finish, the coloring cake is made by mixing two parts of beeswax to one of

fat or suet, and then adding a sufficient amount of 4F abrasive and a good grade of pulverized crocus until the proper consistency is obtained. The proportion of abrasive and crocus should be 3 to 1. The crocus should be used judiciously, because if too large an amount is added it gives the work a milky appearance. When using cut cake or coloring cake, the wheels are stoned down, and for coloring, the face is rubbed with soft charcoal.

While grease and oils are commonly used in the finishing operations of metal polishing, these may be rendered ineffective if the abrasive is too sharp. Natural emery, the cutting action of which is modified by the presence of certain foreign matter, is considered most satisfactory for the final finishing operations. In fact, artificial abrasives are rarely suitable for the last operations in fine finishing.

Wheels for Surfaces not Easily Accessible

Although large-diameter wheels, up to about 24 inches, are most suitable for general work, as it is possible to obtain high surface speeds without high rotative speeds, there are certain classes of work on which a large wheel cannot be used. Narrow work, as, for example, the small blades of pocket knives, requires a small-diameter wheel, so that less wheel contact is obtained. Of course, a small-diameter wheel must be used where curved surfaces of small radius are to be finished. The use of straps coated with a suitable abrasive is quite common for such work as polishing between the tines of forks and the interior of scissor loops and surgical instrument handles. Usually, a flat cotton webbing about 1/2 inch wide is used for scissors, and any desired width for fork tining. This webbing is coated with the proper abrasive. The use of belt polishing machines is gaining more and more ground, and is being applied to an increasingly greater variety of work.

Polishing Non-ferrous Metals

Aluminum, brass, and bronze are more readily reduced in area and surface than iron or steel. Aluminum sand castings may be finished by coarse buffing, using a fast-cutting tripoli, pumice, or rotten stone, followed by coloring with a soft buff and the finer abrasives, such as Vienna lime or nickel polish. The polishing of aluminum should be done at slower speeds than similar work on steel. The practice of aluminum polishing will, of course, differ if the part is produced by die-casting instead of in a sand mold. A die-cast aluminum part can generally be polished in one operation, using the finer cutting abrasives and a quilted wheel. A soft compress canvas wheel may also be used on aluminum. These wheels should be set up with a head of abrasive varying in grain size from No. 120 to 180, depending on the nature of the surface. These wheels are used with grease such as tallow or wax.

Brass and bronze are more granular than aluminum, and can be ground more readily. The ductility of aluminum hinders a free cutting action of the abrasive, a condition which is not encountered when polishing brass or bronze. The same abrasives and the same wheel speeds may be used for brass as for steel. A heavier frictional contact is usually employed, because, as a rule, with a metal of lower tensile strength greater pressure is used in polishing. If the same pressure were used in polishing steel as is permissible with brass, the heat produced would quickly melt the glue and cause the emery to come off the face of the wheel. This is a matter which must be left largely to the judgment of the polisher; he can tell when too much pressure is being applied, because he holds the piece in his hand and it becomes quickly heated when the friction is too heavy.

Buffing Methods

Although buffing, strictly speaking, does not come within the scope of this article, it is so closely related to polishing that a general statement regarding buffing should be included. Buffing is often erroneously referred to as polishing, but a distinction should be made between the two processes. Polishing is regularly performed with wheels that have been prepared with a coating or a head of some kind of abrasive and glue, whereas buffing wheels do not carry a coating of abrasive material, but are made of open disks of muslin or other soft fabric, and the abrasive material (which is in brick form) is applied by hand intermittently during the course of the operation.

Plated steel is usually colored on a buff with "XXXX White Diamond" or any other special buffing composition, such as emery cake, which is a composition of wax or tallow into which certain proportions of No. 200 F. or flour emery have been mixed. This operation is known as nickel buffing. High-grade plated steel is also colored before plating. If a compress polishing wheel is used, with cut cake, the operation is known as coloring. If, however, the coloring is done on a buff, feeding the wheel with cake tripoli, for example, the operation is known as buffing. Although the methods followed in this work are widely divergent, it is always necessary to color steel in some way before plating, when the highest quality of plated surfaces is required.

In buffing brass, tripoli cake is used for cutting, and for coloring, a soft canton flannel wheel is used with a coloring cake consisting of Vienna lime, wax, and grease. Sand buffing is really grinding, and is an operation which is used to refine the surface of white metal, aluminum, and similar materials. In sand-buffing, pumice, rotten-stone, or flint is used as the cutting medium. Crocus polishing, in which crocus cake is used on the wheel, is applied for the high finishing of unplated metals, and is more in the nature of a buffing operation than polishing, although crocus polishing may be done with a leather polishing wheel if the grain of the leather is open and porous.

* * *

INDUSTRIAL CONDITIONS IN SWITZERLAND

A very large percentage of the goods manufactured in Switzerland must be exported, because the home consumption, on account of the size of the country, is small. Watchmaking, as is well known, is one of the important industries. The most important customer in the past for Swiss watches was England. On July 1 this year a very heavy duty was placed upon watches by that country, and hence, the exports during the last few months have been very small.

The greatest difficulty in other industries in Switzerland is the inability of manufacturers to produce a high-class product at a price that is attractive to foreign consumers, compared with the cheaper products produced abroad, or compared with such goods as are made in countries having a depreciated currency. The Swiss metal-working industry, in order to become truly prosperous, must be able to continue to produce a high-grade product, but at a lower price, which means improved manufacturing methods and the use of labor-saving machinery and equipment. To the extent that American machine tools and shop equipment will aid in reducing costs more than can be done by using European machine tools, they will find a market in Switzerland. At the present time, the branches of the Swiss metal-working industry that are best employed are those making radio and talking machine parts, screw products, electrical machinery, hydraulic turbines, knitting machines, some lines of woodworking machinery, and some automobile shops making small cars and trucks.

An amusing incident is mentioned by a Swiss dealer: "The other day the superintendent of a railroad repair shop complained to me that the general manager of the road had refused to buy any more American machine tools, because he could not get repair parts for a turret lathe that he had bought twenty years ago. He said that 'these Americans are changing their designs too often.' The most interesting fact in this connection is that the government railway department that employs this general manager of its machine shop has been very progressive in regard to the development of new designs of locomotives, and especially in replacing the older steam engines by electric engines."

Using Rotating Tables on Multiple Drills

By W. F. SANDMANN

TO obtain the best returns on a machine tool investment, it is necessary that the machine be kept in as nearly continuous production as possible. As the operator's time represents part of the running expense of the machine, the demands upon him should be such as to eliminate idleness and yet, at the same time, keep him safely within the normal fatigue limits.

Machine tool builders in general are endeavoring to design their products so that they will require a minimum amount of attention and have as few idle periods as possible. In many cases, this has resulted in expensive and complicated machines. The National Automatic Tool Co., builder of multiple drilling and tapping machines, has, by adding a rotating table to its standard machines, obtained production units that are capable of practically continuous drilling, reaming, or tapping operations.

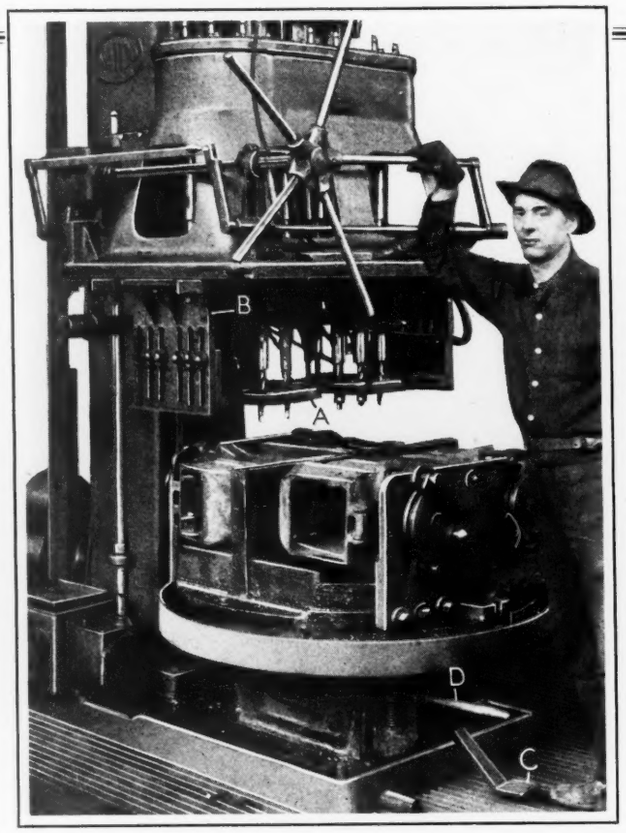


Fig. 1. Multiple-spindle Drilling Machine provided with Rotating Table and Fixed Type of Bushing Plate

In using a rotating table, the operator loads the fixtures at the front of the machine while the parts held in fixtures at the rear are being machined. The important point, in laying out a job for the rotating table, is to see that the time required to load and unload the fixture is approximately equal to the time required for the actual drilling or reaming operation. Designers sometimes endeavor to crowd too many parts on the table at once, with the result that twice as much time is required to load the fixtures as to perform the necessary machining operations. This means that the machine is idle for approximately 50 per cent of the time.

Combined Drilling and Tapping Machines

The use of a rotating table on a multiple-spindle drilling machine such as shown in Fig. 1 makes possible the combining of such operations as drilling and reaming, drilling and tapping, and reaming and facing. The combining of drilling and tapping operations has proved very effective in saving time. At *A*, Fig. 2, is shown a diagrammatic lay-out for a simple drilling and tapping job. The table is indexed 90 degrees to accommodate four stations, but only two fixtures are used. Station 1 at the front of the table is employed for loading and unloading the fixtures. Station 2 is an idle station. Station 3 is employed for drilling, and Station 4 for tapping, both of the latter stations being under the head of the machine, as indicated in the illustration.

As all the spindles of a multiple drilling machine must be fed downward simultaneously, it is evident that tapping, because of the lead of the taps, cannot be done while the drilling operation is taking place, as the drill must be fed into the work more slowly than the taps. The drilling is done at Station 3 while the operator is engaged in loading another part at Station 1 in the other fixture. Stations 2 and 4 are idle. As soon as the drilling operation is completed, the table is indexed 90 degrees, which brings the fixture containing the drilled part under the tapping spindles in Station 4, while the loaded fixture is brought to Station 2, which is idle.

The tapping operation is performed quickly, and as soon as it is completed, the table is indexed another 90 degrees, bringing the finished part back to Station 1 for removal from the fixture, while the part in the other fixture is being drilled at Station 3. At every second indexing movement of the table, the drilled and tapped piece is removed. The suspension plate containing the drill guide bushing is used at Station 3. No guides of any kind are employed for the

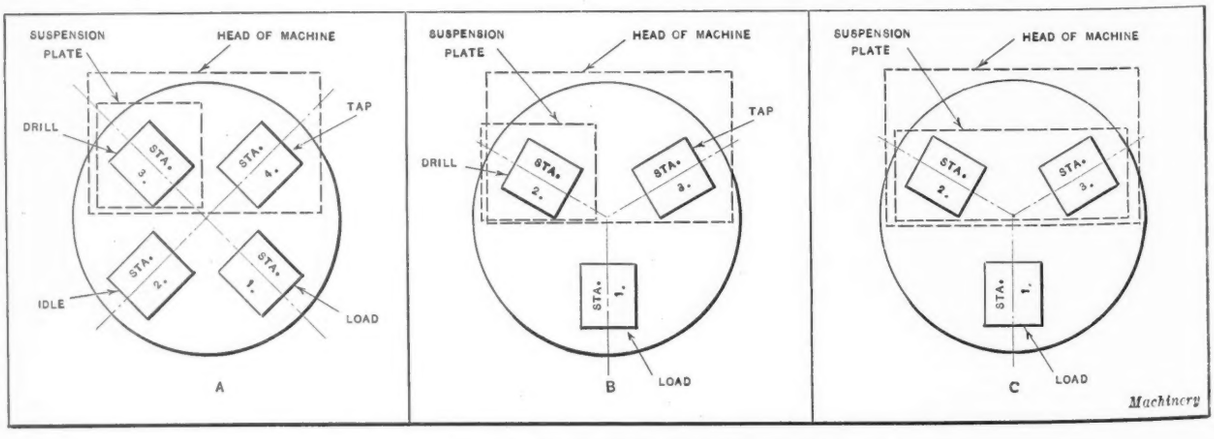


Fig. 2. Diagrams showing Applications of Rotating Tables

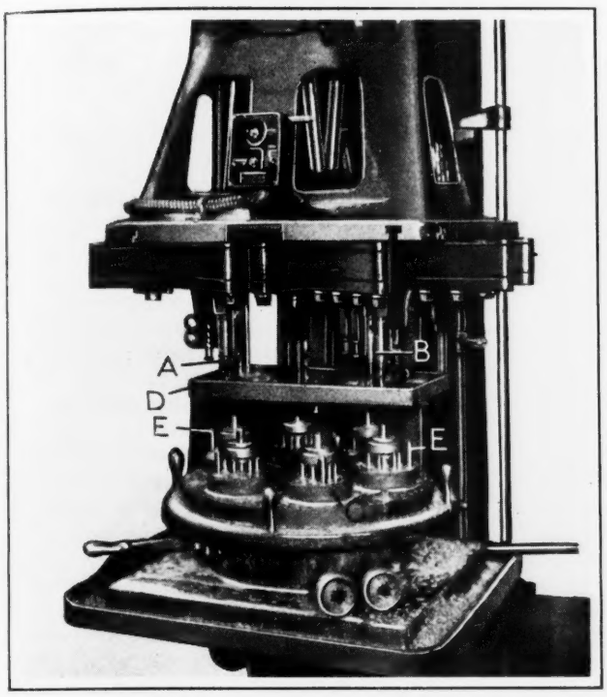


Fig. 3. Multiple-spindle Drilling Machine set up for drilling the Transmission Unit shown in Fig. 6

taps at Station 4. The drilling and tapping spindles are geared to run at suitable speeds.

At *B*, Fig. 2, is shown a set-up employed when the drilled holes pass entirely through the work and enough clearance is allowed to permit the drills to project through the work a distance equal to about 1 1/2 times the length of the drilled hole. The rotating table is indexed 120 degrees. Station 1 is used for loading and unloading, Station 2 for drilling, and Station 3 for tapping. While the drilling operation is being performed, the operator loads a fixture at Station 1. As

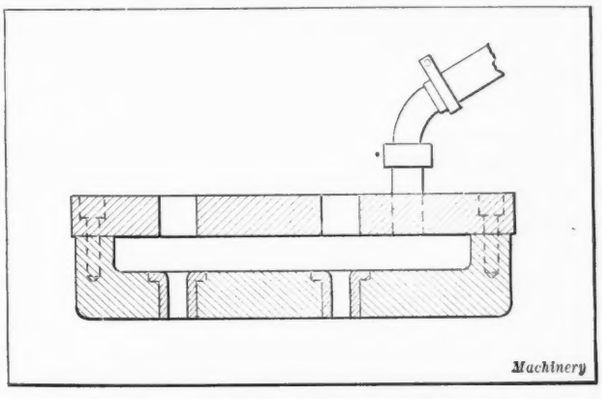


Fig. 4. Bushing Plate with Oil Cavity

soon as the drills pass through the work, the taps begin the tapping of the holes previously drilled at Station 2. As soon as the tapping operation is completed, the table is indexed one-third revolution, and while the drilling operation is being performed at Station 2, a drilled and tapped piece is removed at Station 1. The suspension plate is used only at Station 2 for carrying the drill guide bushings.

Combined Drilling and Reaming Operations

The combination of drilling and reaming operations serves to keep the machine in practically continuous operation. At *C*, Fig. 2, is shown the arrangement of a three-station table in which Station 1 is used for loading, Station 2 for drilling, and Station 3 for reaming. While one piece is being drilled, the piece previously drilled in the preceding operation is reamed, and the operator unloads the drilled and reamed piece from the fixture at Station 1. The drilling and reaming spindles do not run at the same speed, but at speeds best adapted for their own individual work. Bushings for the drills are carried at one end of the suspension plate, and guide bushings for the reamers at the other end. A great variety of work can be handled by using a rotating table on a multiple drilling machine that is arranged for tapping and that has individual spindle speeds. In planning operations, it is best to have the lay-outs made full size on drawing paper, in order to make sure that the stations will not be crowded to such an extent as to cause spindle interference.

Set-up for Drilling Closely Spaced Holes

In Fig. 3 is shown a "Natco" multiple drilling machine set up for drilling a number of holes in the transmission unit shown in Fig. 6. The small size of the part and the close spacing of the holes make it necessary to perform two drilling operations on each piece. The table is of the three-station indexing type, and two pieces are drilled at each station. Half of the holes in two pieces are drilled at the first station *A*, Fig. 3, after which the table is indexed and the remaining holes are drilled in the same pieces at station *B*. Station *C* at the front of the table is used for loading and unloading. With the arrangement shown, two completely drilled pieces are removed from the table after each indexing movement.

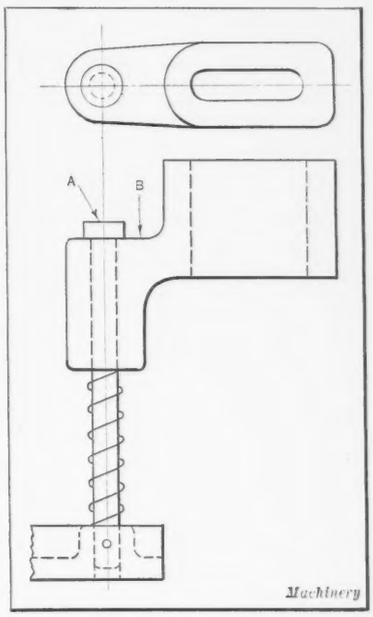


Fig. 5. Bushing Plate Suspension Arm

The bushing plate *D* is suspended from the head of the machine by three arms, and is located by two pins *E* at each downward stroke of the drilling head. Fig. 5 shows one of the bushing plate suspension arms. This type of arm is used extensively for suspending bushing plates from the heads of multiple drilling machines. When the plate comes to rest, the suspension rod continues to feed up through the arm as the head of the machine moves on downward. When the machine head is raised, the springs force the plate down until the heads *A* of the suspension rods come in contact with the bracket *B*.

The suspension plate and arm has several advantages over other methods of supporting or guiding the drills when rotating tables are employed. Only one set of drill bushings is required when the suspension plate and arm method is used. The drills do not run in the bushings except during

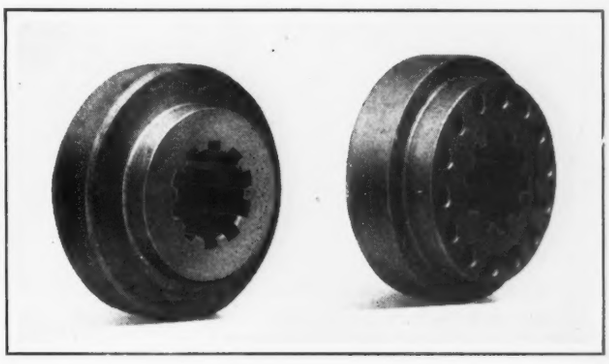


Fig. 6. Example of Close-spaced Drilling

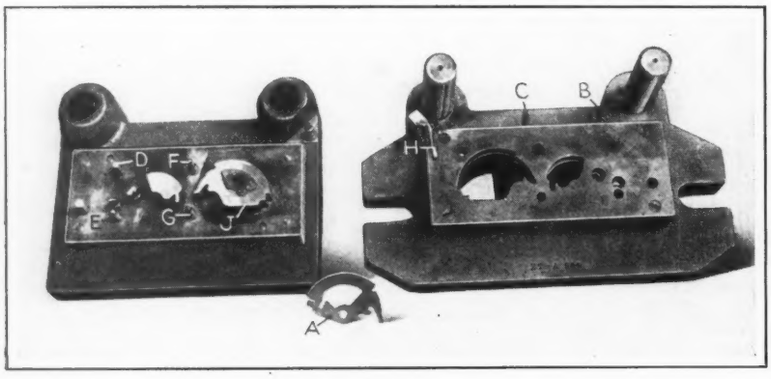


Fig. 1. Progressive Die used for producing Gear Segment A from Strip Stock

the actual drilling operation. Furthermore, there is no jig lid to be lifted from the fixture at the unloading position, a feature which saves considerable time.

Fixed Type of Bushing Plate

In Fig. 1 is shown a multiple drilling machine on which a fixed type of bushing plate is employed. Although very satisfactory for many jobs, this type of plate is not recommended for work that is required to be very accurate. The bushing plate *A* is suspended from the head of the machine by fixed brackets *B*, which are provided with slots for adjustment purposes. The alignment of the head of the machine with the rotating table is depended upon entirely for locating the bushing plate, which does not come in actual contact with the fixture. The drills rotate continuously in the bushing with their points projecting beyond the bushing plate far enough to drill the holes to the required depth. This arrangement has been employed successfully for drilling rivet holes in journal boxes which had previously been punched. These journal boxes are made in two parts, and fixtures are employed to hold the two parts together while drilling the holes.

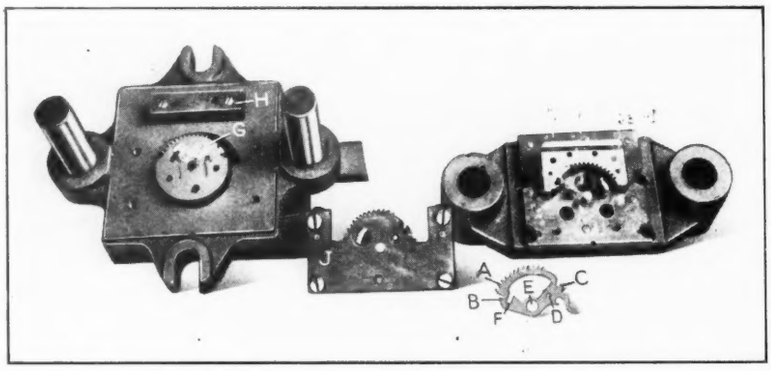


Fig. 2. Die used for blanking the Teeth on the Part

When the operator depresses the foot-pedal shown at *C*, the table top is lifted a fraction of an inch from its ways on a large central ball bearing. By pulling up on the lever *D*, the locking bolt is withdrawn so that the table may be swung around to the next position where it will again be locked by the locating bolt. The operator can then release the foot-lever and allow the table top to settle back on its ways. The tables are generally indexed 60, 90, or 120 degrees. The holding fixtures used on these tables are generally designed for a given piece of work. Sometimes they are made in individual units, and each unit mounted separately on the table. More often, however, they are constructed with the units permanently mounted on a large base which is bolted directly to the table. This permits the fixtures to be changed very quickly.

The dowels or pins used to locate the bushing plate on the fixture should be at least 1 inch in diameter and have conical tops. The conical top is necessary because the suspension plate is likely to sway on the arms and thus bring the holes slightly out of alignment with the pins. If desired, the suspension plate can be made with a cover as shown in Fig. 4. The cutting compound is then pumped into the reservoir-like part from which it flows directly to the drills.

* * *

DIES FOR MAKING SMALL GEAR SEGMENTS

In the Barrett portable adding, listing, and calculating machine manufactured by the Lanston Monotype Machine Co., Philadelphia, Pa., there are a number of small gear segments which are made by means of the die sets shown in Figs. 1, 2, and 3. These segments are produced from hard strip steel, 2 1/4 inches wide by 0.031 inch thick. The progressive punch and die illustrated in Fig. 1 blanks and pierces the part as shown at *A*.

In starting a new piece of stock through the die, it is fed to stop *B*, and on the descent of the punch five holes are pierced. The stock is then fed to stop *C*, and on the second descent of the ram the entire odd-shaped inside hole of the part is blanked out. To locate the stock accurately for this step, pilots *F* and *G* enter the two holes pierced by punches *D* and *E* in the first step. Stop *C* is next withdrawn, and the stock fed against spring stop *H* for the third descent of the ram, during which the outside of the part is blanked to the outline shown at *A*. The work is located in this step by the pad on the bottom of punch *J* entering the large opening in the part. After one piece has been produced from a given piece of material, stops *B* and *C* are not required until a new strip is started through the die.

Fig. 2 shows the second die set used for blanking teeth *A* on the part, bending back lugs *B* and *C*, piercing hole *D*, and shaving hole *E* and slot *F*. In this operation, twelve teeth of 0.1963 inch circular pitch are blanked to a pitch radius of 1.4996 inches. The piece is located by slipping it on pad *G* of the die. Block *H* backs up the punching unit against the thrust of the operation, while stripper plate *J*, which is attached to the punch, prevents work from adhering to the punch on the return stroke.

The third die set, which is illustrated in Fig. 3, is used merely to shave all burrs from the teeth. The work is located by pilots *A* and *B* which enter holes *C* and *D* in the work. This die is also equipped with a block *E* which, together with the guideposts, prevents the punching unit from moving endwise under the pressure of the operation.

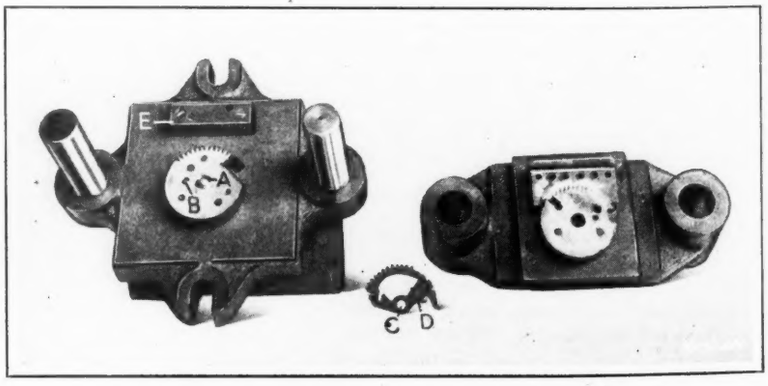


Fig. 3. Final Die, employed for shaving all Burrs from the Segment Teeth

Equipment for Railroad Tool-rooms*

By C. A. SHAFFER

IN the apparent increasing tendency toward better and more complete shop machinery and other facilities for making repairs to locomotives and cars, the matter of suitable equipment for the maintenance of all tools with which that work must be done should not be overlooked. In the past, it is quite evident that due consideration has not been given to equipping the tool department to the best advantage for making and maintaining in first-class condition such tools as may be required. This is true of many shops from the largest to the smallest; and, at present, when the importance of good tools is being generally recognized, it may not be amiss to discuss the question of tool-room machinery.

The tool department of any railroad shop should be adequate to maintain properly and economically, all tools used locally or under that shop's jurisdiction. Obviously, it is impossible to work out a definite list of machinery and equipment that would be practicable to meet the requirements of all shops, due to the various methods used by different railroads for handling this work; also the kind and amount of work to be done and local conditions must be considered. Therefore, it would seem desirable to submit, say, three groups of equipment for use either separately or in whatever combination may be best suited to meet the requirements of individual cases.

Some of the larger railroads make it a practice to have centralized tool-rooms, usually located at their main shops, where certain standardized tools are made for the entire railroad and shipped to the different points on requisition. These are generally known as manufacturing tool-rooms, and require somewhat greater and more diversified lots of equipment than the tool departments where only maintenance or reconditioning work is done. However, the majority of railroads have tool departments at their main shops where all local tool maintenance and repairs are taken care of, and, possibly, some new work, as in emergency cases or for making occasional replacements.

Selection of Tool-room Equipment

In selecting a list of tool-room machinery, there are a number of important points to be considered, the principal ones being as follows:

1. Are new tools to be manufactured and if so, what kind and to what extent?
2. Will all classes of work pertaining to the upkeep of tools for every department be performed?
3. Is the equipment, both as regards size and design, suitable for future requirements or expansion?

For the three groups mentioned, the following machines are suggested. Description of individual items is brief and confined to the kind or type of machine and principal dimensions or features. The maker's name has been purposely omitted. All the machines are to have individual motor drives, and they are to be equipped with suitable push-button control.

Group No. 1—Equipment for General Tool Manufacturing and Maintenance Department

Engine Lathe: Nominal size, 20 inches by 10 feet. Equipment, taper attachment; 16-inch four-jaw independent chuck.

Engine Lathe: Nominal size, 18 inches by 8 feet. Equipment, taper attachment; 14-inch four-jaw independent chuck.

Tool-room Lathe: Nominal size, 16 inches by 8 feet. Equipment, taper attachment; draw-in attachment; universal relieving attachment; and one universal and independent chuck.

Tool-room Lathe: Nominal size, 14 inches by 6 feet. Equipment, taper attachment, draw-in attachment, universal relieving attachment; and one universal and independent chuck.

Precision Toolmaker's Lathe: Nominal size, 10 inches by 4 feet. Complete equipment.

Turret Lathe: Nominal size, 3 inches by 36 inches. Bar stock and chucking equipment.

Horizontal, Knee-type Universal Milling Machine: Nominal size, No. 4.

Horizontal, Knee-type Universal Milling Machine: Nominal size, No. 3.

Horizontal, Knee-type Universal Milling Machine: Nominal size, No. 2.

Vertical Milling Machine: Nominal size, No. 4 or 5.

Crank Shaper: Nominal size, 24 inches.

Crank Shaper: Nominal size, 16 inches. Equipment, universal table.

Vertical Shaper or Slotter: Nominal size, 10 inches. Equipment, angle adjusting head; and universal table.

Radial Drill Press: Nominal size, 24 inches by 2 inches capacity. Equipment, reversing attachment.

Upright Drill Press, Reversible: Nominal size, 20-inch by 1 1/4-inch capacity. Equipment, compound table; and universal vise.

Precision High-speed Drilling Machine: Nominal size, 14-inch by 1/2-inch capacity. Equipment, square and round tables; V-cup and point center.

Extra Heavy-duty Universal Grinder: Nominal size, 12 inches by 36 inches. Equipment, internal and radius attachments.

Universal Cutter and Reamer Grinder, Medium Service: Nominal size, 10 by 36 by 24 inches table travel. Equipment, complete with power and hand feeds, with all attachments.

Automatic Wet Surface Grinder: Nominal size, 8 inches by 24 inches. Equipment, universal vise; and magnetic chuck.

Heavy Universal Tool Grinder

Twist Drill Grinder: Nominal size, 1/4 inch to 3 inch capacity.

Tap Grinder: Nominal size, capacity up to 3 inches.

Universal Die Chaser Grinder: Nominal size, capacity for all sizes.

Disk and Belt Grinder, Polisher and Buffer: Nominal size, 9 inches.

Double Floor Stand Grinder: Nominal size, 10-inch by 1-inch wheels.

Double Floor Stand Grinder: Nominal size, 14-inch by 2-inch wheels.

Floor Stand Type Arbor Press: Nominal size, medium.

Power Hacksaw: Nominal size, 6-inch capacity.

Furnace, Electric or Gas: Nominal size, 8 by 12 by 26 inches.

Furnace, Electric or Gas: Nominal size, 4 by 8 by 12 inches.

Crucible: Nominal size, 10 inches by 24 inches.

Furnace, Automatic Electric Tempering: Nominal size, 12 by 18 by 24 inches.

Immersion Tank: Size, 24-inch by 36-inch oil tank with 36-inch by 36-inch water jacket.

Air Flow Meters

Air Tool Testers

Scleroscope and Other Measuring or Testing Instruments

*Abstract of a paper presented before the American Railway Tool Foremen's Association convention.

Group No. 2—Equipment for Medium Size Shop Doing Mostly Maintenance Work

Engine Lathe: Nominal size, 20 inches by 10 feet. Equipment, taper attachment; 16-inch four-jaw independent chuck.

Tool-room Lathe: Nominal size, 14 inches by 6 feet. Equipment, taper attachment; draw-in attachment; universal relieving attachment; and one universal and independent chuck.

Horizontal, Knee-type Universal Milling Machine: Nominal size, No. 3.

Crank Shaper: Nominal size, 16 inches. Equipment, universal table.

Upright Drill Press, Reversible: Nominal size, 20-inch by 1 1/4-inch capacity. Equipment, compound table and universal vise.

Universal Cutter and Reamer Grinder, Medium Service: Nominal size, 10- by 36- by 24-inch table travel. Equipment, complete with power and hand feeds, with all attachments.

Twist Drill Grinder: Nominal size, 1/4-inch to 3-inch capacity.

Tap Grinder: Nominal size, capacity up to 3 inches.

Universal Die Chaser Grinder: Nominal size, capacity for all sizes.

Double Floor Stand Grinder: Nominal size, 14-inch by 2-inch wheels.

Floor Stand Type Arbor Press: Nominal size, medium.

Furnace, Electric or Gas: Nominal size, 8 by 12 by 26 inches.

Furnace, Electric or Gas: Nominal size, 4 by 8 by 12 inches.

Immersion Tank: Size, 24-inch by 36-inch oil tank with 36-inch by 36-inch water jacket.

Air Flow Meters

Air Tool Testers

Scleroscope and Other Measuring or Testing Instruments

Group No. 3—Equipment for Smaller Shop Where the Only Work Done is Reconditioning of Tools Generally Used on Running Repair Work

Engine Lathe: Nominal size, 20 inches by 10 feet. Equipment, taper attachment; 16-inch four-jaw independent chuck.

Upright Drill Press, Reversible: Nominal size, 20-inch by 1 1/4-inch capacity. Equipment, compound table and universal vise.

Universal Cutter and Reamer Grinder, Medium Service: Nominal size, 10- by 36- by 24-inch table travel. Equipment, complete with power and hand feeds, with all attachments.

Twist Drill Grinder: Nominal size, 1/4-inch to 3-inch capacity.

General Recommendations for the Different Groups

Regarding the first group of equipment in the foregoing list (comprising thirty-six items) it should be remembered that while the number of machines may appear excessive, an outfit about equal to this would be required to properly handle the work of manufacturing on a paying basis, certain new tools, such as reamers, cutters, taps, forging dies, jigs, fixtures, and other special tools in quantities for general use at all shops, in addition to maintaining all local tools; however, it is believed that the necessity for manufacturing such tools as, reamers, taps, drills, threading dies, etc., is diminishing and the possibilities for effecting savings in this line are remote. This is due to keen competition among commercial manufacturers and the fact that several reputable concerns are now listing as standard such tools as were considered special a few years ago and were priced accordingly.

There are many special time-saving tools and devices being manufactured and used today that had their origin and development in the railroad shop and that cannot be obtained elsewhere. These, together with forging and forming dies or other equipment of similar construction, give reason for a full complement of machinery in the tool department of an up-to-date railroad shop.

In the second group (comprising seventeen items) are shown such machines as may be considered adaptable for the average medium-sized shop to take care of occasional replacements and specialties in the way of new tools and the complete repairs and reconditioning of existing equipment.

The third group (comprising only four items) is suggested for outlying shops to handle limited light repairs to local shop equipment and sharpen such hand tools as drills, reamers, taps, thread chasers and cutters which would otherwise have to be shipped to a larger shop for reconditioning.

* * *

TRADE ASSOCIATION STATISTICS

For years, trade associations have been faced with doubts about the statistical activities in which they could lawfully engage. The members of many associations had come to fear that statistics of any kind were, in the opinion of the Government, inherently wrongful, when they related to economic activity, although in every other walk of life statistics were held in high esteem. In this situation, the Supreme Court itself has granted relief. It has handed down opinion in two cases brought by the Department of Justice against trade associations, holding that the statistical activities of these associations were lawful. Thus, these opinions serve to indicate for all trade associations that there is no violation of the federal anti-trust laws if they gather and distribute the essential business facts that the Supreme Court described.

With the clearer understanding of this liberty under the law (which remains unchanged), there is no bar to the development and proper use of business statistics. This clearing of the atmosphere should mark the passing of guessing as to the facts concerning our commodity production and distribution, provided there is a willingness, at the source, to supply the information. It is in the hands of each member of an industry to make possible complete and accurate figures for his line by his own contribution.

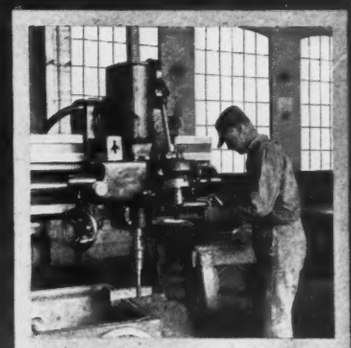
With these rulings as a basis, trade associations will undoubtedly appreciate the opportunity of rendering to their constituency a valuable service by providing means for gathering and reporting statistics dealing with such important trade information as producing capacity, orders, shipments, stocks and markets, as shown by prices on closed transactions. In the renewing of statistical activities, it is timely to suggest simplification of methods and forms in order that the information which is found be obtained and presented as quickly and accurately as possible at the minimum of expense. Such uniformity will enable the transmission of information gathered in the form of charts or graphs, when desired, much less cumbersome than presenting great masses of figures. If uniformity of method is observed, it will greatly simplify the matter of not only charting a given line, but also including such other lines as may be of collateral interest or important in comparing the trends of the industry. One of the important essentials of statistics is that they shall be fresh as well as dependable. A very encouraging number of trade associations is at present actively engaged in gathering and distributing such information, and many others are familiar with the methods of doing so properly.

Considering the present state of business and the dearth of such information as an aid to intelligent individual control in industry, it is expected that a large number of associations will avail themselves of this opportunity to participate in a cooperative study of ways and means whereby statistics may best be developed and handled.

* * *

An international exhibition for the utilization of hydraulic power is to be held at Basle, Switzerland, July to September, 1926. The first sectional conference of the World's Power Conference will also be held in the same city during the exhibition. Further information may be obtained from the Swiss Consulate in the United States, 104 Fifth Ave., New York City.

Letters on Practical Subjects



A QUICK-ACTING CLAMP

The toggle-joint type of clamp shown in the accompanying illustration provides an effective means of clamping work in place by simply swinging a lever through an angle of 180 degrees. When the points *A*, *B*, and *C* are in a straight line, as indicated in the view at the left, the clamping bar *D* cannot be raised, but as soon as the handle *E* is moved in either direction, the clamping bar will begin to rise. In order to make the clamp irreversible, a stop *F* is welded to the top of the bar *D*. This stop is a piece of round or square steel, so located that it will let the handle *E* just pass the position in which points *A*, *B*, and *C* are in line. This causes the clamp to be locked tight and does not permit it to open under pressure.

The view at the left-hand side of the illustration shows the clamp in the closed position, and the full lines in the right-hand view show the clamp partly open, while the dotted lines show the movable members of the clamp in the positions they occupy when the clamping bar *D* is swung away from the work through an angle of 180 degrees. The clamping bar *D* is held between the side plates *H* by the rivet *I*. The handle *E* is connected with the bar *D* by the rivet *B*, and the links *J* are fastened to the handle *E* and to the side plates *H* by means of the rivets *A* and *C*. The spacers *K* hold the handle and side plates apart and prevent the moving members from binding. The spacers *L* and *M* hold the links away from the inner members, and thus prevent friction at these points.

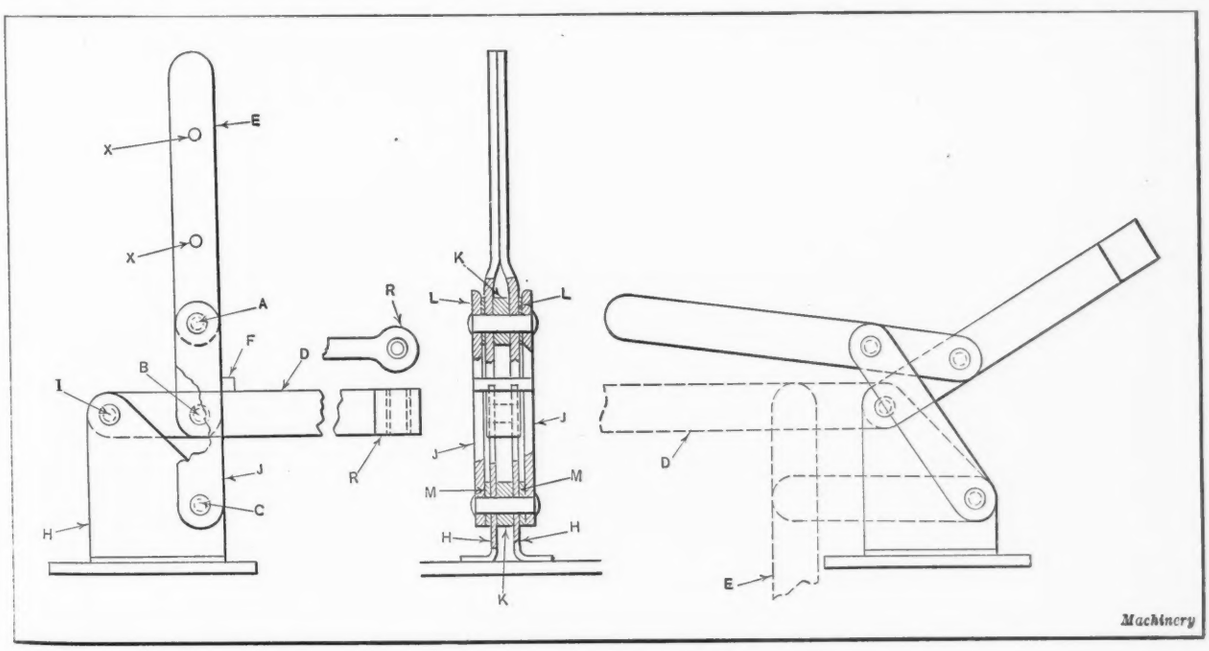
The two pieces of steel that form the handle *E* may be joined together by spot-welding or by rivets at the points *X*. The upper end of this handle can be bent to various angles to suit the conditions. Bar *D* may be made from cold-rolled steel and the head *R* welded to it. A stud with a lock-nut is placed in the threaded hole in the head *R*, and adjusted so that the point will bear on the work with the required pressure.

Cleveland, Ohio EDWARD HELLER

DEEP DRAWING DIES

The deep drawing die shown in Figs. 1 and 2 was developed for use on a double-action press. Under favorable conditions a die of this design will produce a shell in one operation that ordinarily requires two or three operations on the usual type of drawing die. It is also claimed that the shell will have a finer finish, greater accuracy, and will not ordinarily require annealing, unless a spinning operation is to be performed upon it. Dies of this kind are particularly useful in drawing extremely deep tubes, such as are required for pump cylinders, shot shells, or cartridge cases. The closed end of the shell is left comparatively soft, as there is little displacement of the metal. Hence the shell can easily be headed to form a cartridge case, shot shell, or other products, without requiring an annealing operation. These dies have been used successfully in drawing deep shells from brass, bronze, steel, and various alloys. Patents on the new features incorporated in the die have been obtained by the writer.

The die-holder *A* has cutting and drawing members similar to those ordinarily used on double-acting presses except



A Quick-acting Toggle-joint Type of Clamp

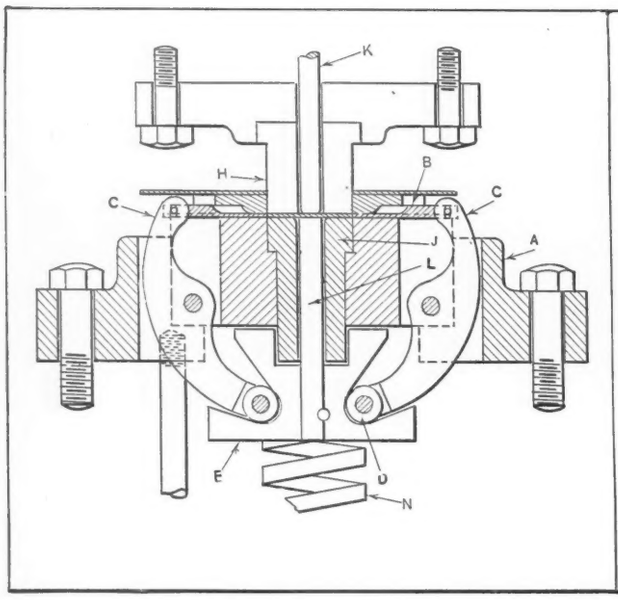


Fig. 1. Sectional View of Deep Drawing Die

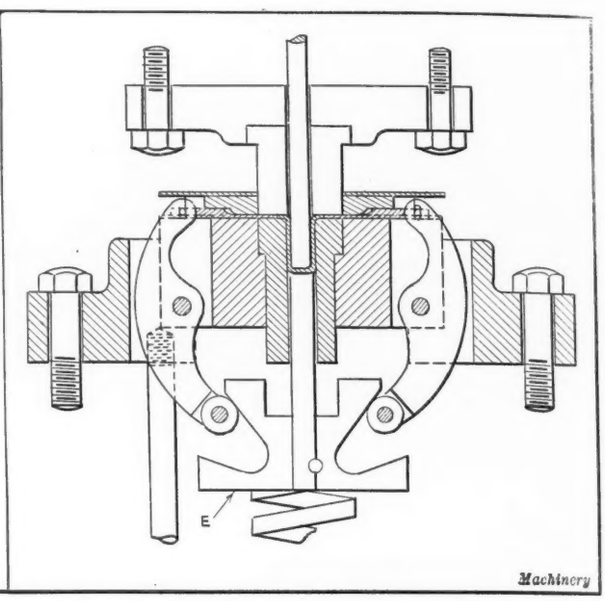


Fig. 2. Die with Drawing Punch near End of Stroke

that a series of radially positioned plungers *B* are provided. A detailed view of one of the plungers is shown at *B*, Fig. 4. These plungers move freely in radial slots, and are connected to rocker arms *C*, which are pivoted in the die-holder. At the lower end of each rocker arm is a roller *D* which normally is in contact with the conical surface of member *E*, Figs. 1 and 2. Although no stock stripper is shown in the illustrations, it is necessary that one be employed, the conventional type being satisfactory for this work. The blank shown at *F*, Fig. 4, which is drawn to form the shell *G* is scalloped, as indicated, in order to facilitate the drawing operation.

When the die is in operation, the blanking punch *H*, Fig. 1, moves downward, cutting the blank to the required size and shape. Upon the continued downward movement of the press ram, the blank is forced down until it rests on the top surface of the drawing die *J* where it is held with just sufficient pressure to keep it from wrinkling during the drawing operation. The drawing punch *K* begins the drawing operation as soon as the blank has been brought into position on the drawing die.

The ejector *L* is carried downward during the drawing operation, causing the cone-shaped member *E* to force the lower ends of the rocker arms *C* outward, which, in turn, causes the plungers *B* to exert an inward pressure on the edge of the blank. The pressure exerted on the edge of the blank is equal on all sides, and tends to force the metal inward in the direction of the opening in the drawing die. The angle of the cone-shaped member *E* need not be exact, as the metal has more or less elasticity. However, if the angle is correct, there will be less wear on the die and less hardening of the metal. The spring *N* serves to return the cone-shaped member to its normal position. On the upward movement of the press ram, the ejector *L*, which is secured to the cone-shaped member *E*, forces the finished shell from the die.

The number of plungers *B* is determined by the shape of the shell to be drawn and its proportions. If the shell is square, four plungers are employed, and if of hexagonal shape, six plungers are used. For cylindrical shells, the number of plungers is determined by the amount of movement required and the general proportions of the shell. Eight plungers will usually be found about right for cylindrical work, as it is often difficult to find space for a larger number of plungers. One holder may be used for several different shells if the difference in size is not too great. A cutting die and punch, a drawing die and punch, an ejector and cone, and a set of plungers will be required for each different size of shell.

Reading, Pa. JOHN J. KAUFFMAN

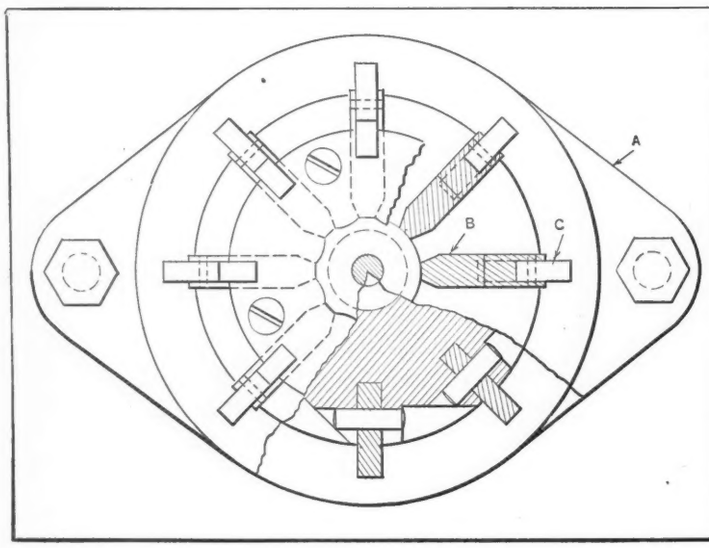


Fig. 3. Plan View of Die shown in Fig. 1

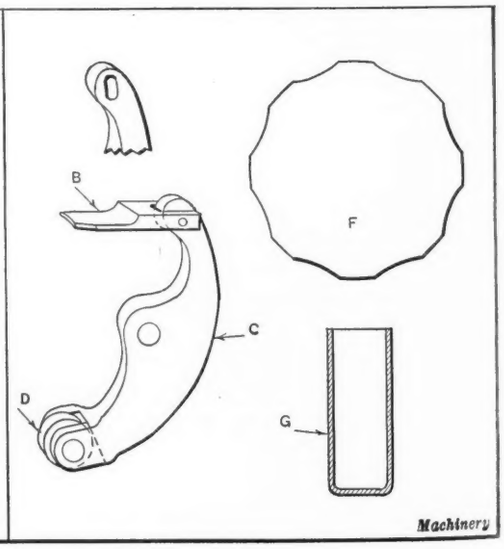


Fig. 4. Parts of Die, Shell, and Blank

SPECIAL TOOL ENGINEERING SERVICE

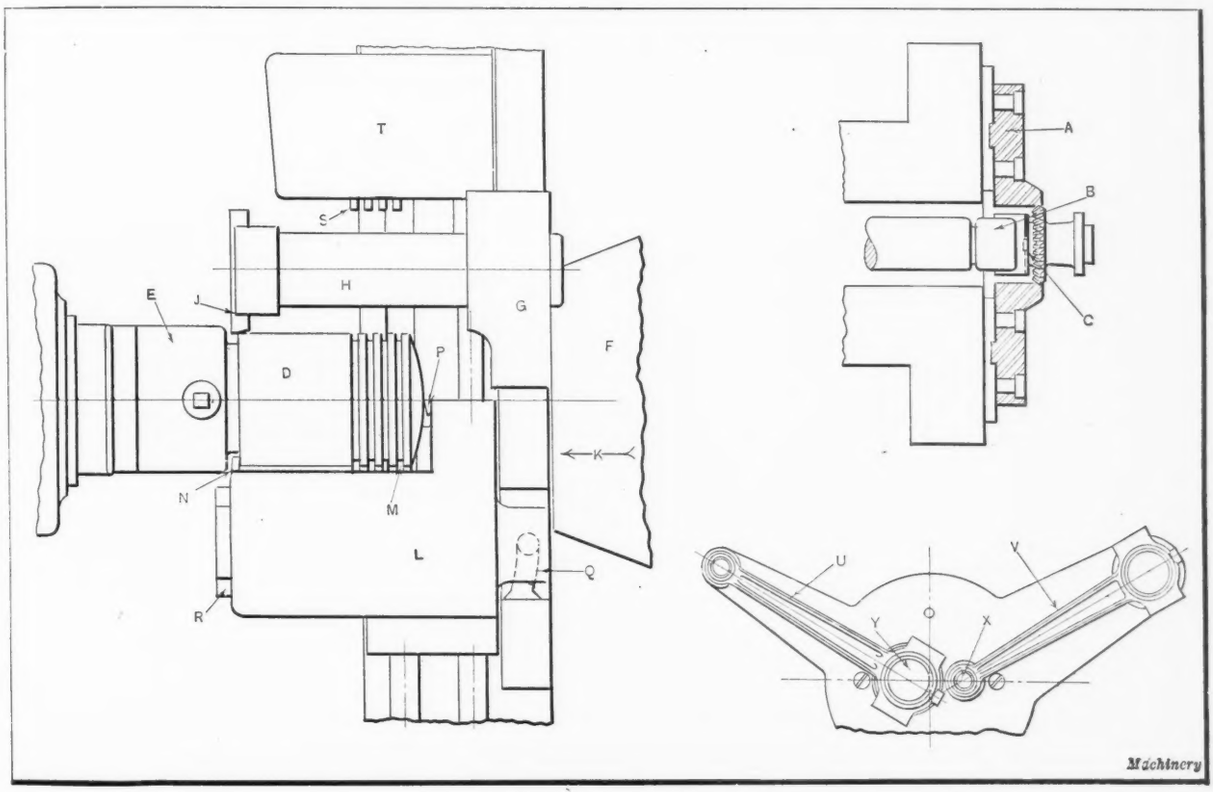
One of the machine tool designer's jobs is to make lay-out drawings showing how certain work should be handled on the machines manufactured by his company. This is the kind of service many purchasers expect, and its object is to show how the machine can be operated in the most efficient manner. The lay-outs for this purpose must be made quickly, and generally they are required to show only the method to be employed without actual construction details.

In the upper right-hand corner of the accompanying illustration is shown a lay-out made for the purchaser of a turret lathe who desired to know how a small bevel gear should be held while performing drilling, boring, reaming, facing, and back-facing operations. The particular gear shown has cast teeth. The customer, being familiar with turret and boring tools and the general operation of the machine, merely desired to know how the work should be held and how the back-facing bar could be used. The lay-out shows a set of chuck jaws *A* mounted on a chuck held to the spindle of the machine, and a back-facing bar *B* operated through the spindle of the machine. The cutter in this back-facing bar serves to face the hub *C* of the gear.

The view at the left shows the tool equipment used in turning the piston *D* which is mounted on an arbor *E*. The arbor enters the open end of the piston, and is provided with expanding members that grip the rough surface of the piston casting. On turret *F* is mounted the tool-holder *G*, which holds a turning bar *H* provided with a cutter *J* that turns the outside of the piston as the turret travels in the direction indicated by arrow *K*. The front cross-slide block *L* is equipped with a series of blades *M* which rough-groove the piston, and a blade *N* which faces the open end. The blade *P* machines the convex end of the piston, the required radius being obtained by a cam groove and roll arrangement shown at *Q*, which operates in connection with a slide *R* in the cross-slide block. The finish-grooving operation is performed by a series of blades *S*, held in the rear cross-slide block *T*.

The view in the lower right-hand corner of the illustration suggests the method to be employed in broaching connecting-rods. In this case, two broaches are used, one for the hole at the large end of the connecting-rod and one for the hole at the smaller end. This permits one connecting-rod to be finished at each stroke of the broaching machine. Diagrams or plans like the ones shown give the prospective customer an idea of how the particular part is to be machined without going into the detail construction of the tool equipment. The customer can have his own engineers design the tools, or the company furnishing the machine may provide equipment of the type shown in the plans.

Holyoke, Mass. FRANK H. MAYOH



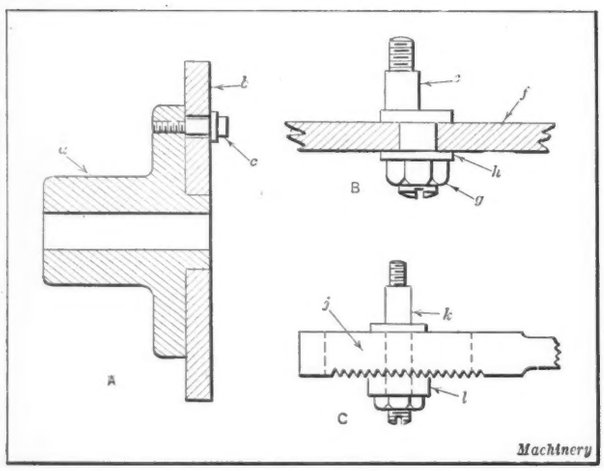
Diagrams showing Proposed Tool Equipment

ADJUSTMENT DEVICES FOR MACHINES

Means for making adjustments on machines are required for three different purposes—(1) to compensate for wear; (2) to adapt the machine for a different piece of work or a different operation; and (3) to adjust the actuating parts of the machine. Examples of devices used for the first two purposes are the wedge gib and the overhanging arm of a milling machine, while cams, gears, and similar parts are examples of parts used for the third purpose. Adjustments to compensate for wear and for setting up the machine are indispensable, but adjusting devices for actuating members of a machine should not be employed except in the construction of model machines for the purpose of trying out and timing new mechanisms. Such devices should not be considered permanent, and they should be eliminated when redesigning the final model.

As few adjusting devices as possible should be used on machines manufactured for the market, because they are often operated by unskilled mechanics or workmen who are inclined to tamper with adjustable members. Another objection to adjusting devices is that they often become loose and slip or change their position, sometimes causing serious damage to the machine. The additional cost of manufacturing and assembling adjusting devices is also an item that must be considered.

In designing a machine or redesigning an inventor's model with the object of placing the machine on the market in large lots, careful consideration should be given the adjustment problem. Only such adjustments as are of permanent value



Devices for making Adjustments on Machine Parts

should be incorporated in the final design. The providing of adjustments as a temporary expedient is poor practice. When adjusting devices are absolutely necessary, care should be taken to make them strong enough to withstand any strains to which they may be subjected.

The type of adjustment for a cam shown at *A* in the accompanying illustration is a decided improvement on the ordinary method of omitting the key and clamping the member to the shaft with a set-screw. A slight adjustment is difficult to obtain when a set-screw is used, as the point of the set-screw has a tendency to enter its original seat when it is tightened. When a set-screw is used, there is always danger that the member will slip on the shaft while the machine is in operation. The adjusting device shown at *A* consists of a two-part member, the hub *a* which is keyed and secured to the shaft with a set-screw, the cam *b* which is fitted to a projection on hub *a* and three studs *c* that pass through three equally distant slots in cam *b*. The position of the cam on the shaft can be changed by loosening studs *c*, setting the cam to the desired position, and tightening the screws firmly in place. A heavy line is scribed across the cam and the hub to indicate the normal position of these two members and also to serve as a guide in making adjustments.

Adjustment for a fulcrum stud may be obtained by employing an eccentric stud, such as shown at *B*. The shouldered stud *e* is fitted into a section *f* of another part, and provided with a nut *g* and washer *h*. The eccentric stud should be a good fit and have one end slotted to permit a screwdriver to be used for adjusting the position of the stud.

At *C* is shown a practical device for adjusting or varying the effective length of a lever or similar part. It is made by providing a slot *j* in the end of the lever to receive the stud *k* which clamps the block *l* to the lever. The block *l* and the end of the lever are serrated to prevent slippage when the nut is tightened.

Pawtucket, R. I. S. W. Brown

HEIGHT GAGE ATTACHMENT FOR VERNIER

Toolmakers and machinists who have vernier calipers can easily make such instruments serve as height gages by providing them with a few parts such as shown in the accompanying illustrations. The base shown at *A*, Fig. 2, is made of tool steel, hardened and ground on the bottom. It will be noted that a recess is cut in the bottom of the base at *B*. The eccentric locking bolt *C* which is used to clamp the base to the vernier, as shown in Fig. 1, is made of brass. At *D*, Fig. 2, is shown the yoke used to clamp the scribers to the upper jaw of the vernier caliper. At *E* is shown a scriber for use in scribing lines close to the surface plate, and at *F* a straight scribing bar for scribing lines at a greater distance from the surface plate. The part shown at *G* provides a means of attaching a dial indicator to the movable jaw of the caliper.

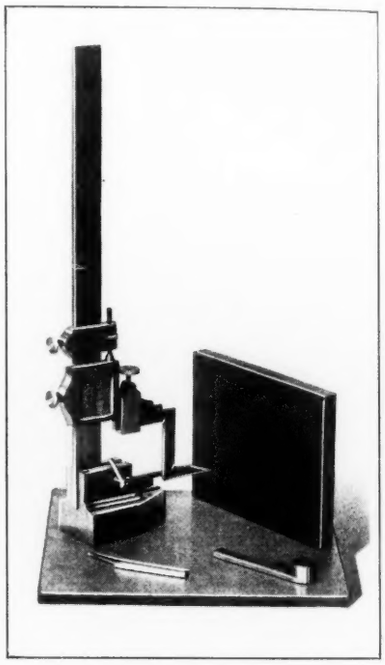


Fig. 1. Vernier equipped with Height Gage Attachments

Philadelphia, Pa. Charles Kugler

* * *

The durability of British aircraft is indicated by a report covering the first year's working of Imperial Airways, Ltd., a company that maintains regular airplane passenger service between London and numerous points on the European continent. In the service of this company, one Handley-Page machine and two De Havilland 34 type machines each completed 2300 flying hours, covering over 200,000 miles each.

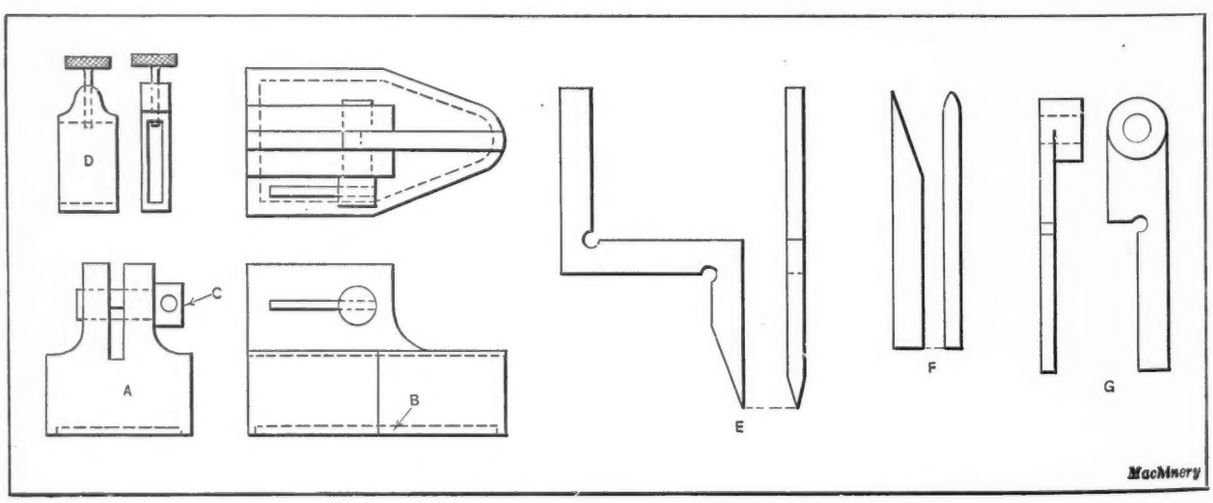
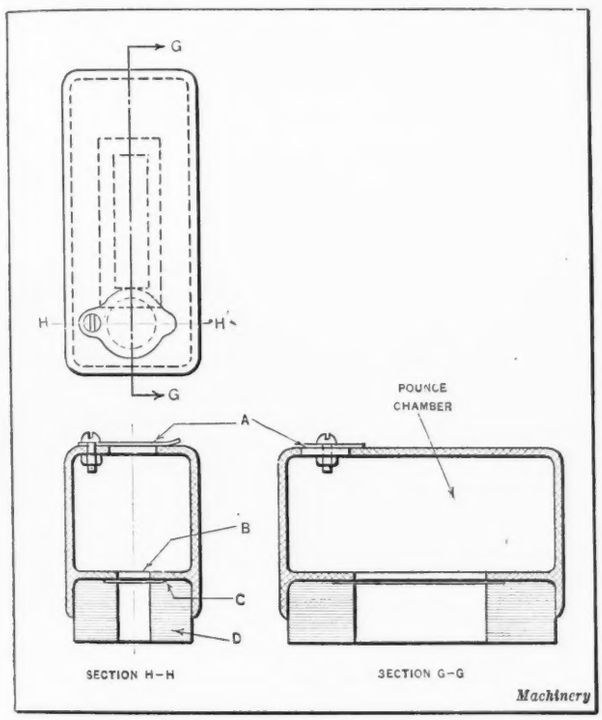


Fig. 2. Height Gage Attachments for Vernier

Shop and Drafting-room Kinks

DRAFTSMAN'S POUNCE-CONTAINER

It is the practice in most drafting-rooms to use pounce on tracing cloth to absorb the oily substance of the wax used in sizing. The usual methods of applying pounce or chalk with a cloth are wasteful and cause an unnecessary amount of dust to be circulated in the air. In the accompanying illustration, is shown a container designed by the writer to permit the pounce to be easily and effectively applied to the tracing cloth.



Pounce-container for the Drafting-room

The pounce is poured through the opening at *A* into the container, which has a capacity of about 16 cubic inches. A No. 82 mesh screen *C* is placed over the opening *B*, and soldered in place. This screen prevents the pounce from falling through the opening from its own weight, but will allow a sufficient amount of the powder to be sprinkled over the tracing cloth when the container is shaken or jarred. The felt pad *D* which is inserted at the bottom of the container is used to spread the pounce thoroughly over the tracing cloth and to remove all surplus powder. As the container is made of aluminum, it weight only 14 ounces. One filling with pounce permits from 375 to 400 tracings to be treated.

Milwaukee, Wis. RICHARD GREINER

PRECISION GRINDING WITH INDEXING HEAD

By holding certain kinds of precision work on an indexing head, for angular grinding, instead of setting it up on an angle-plate, the writer has been able to cut the production time in half and obtain accuracy equivalent to that resulting from the use of a protractor.

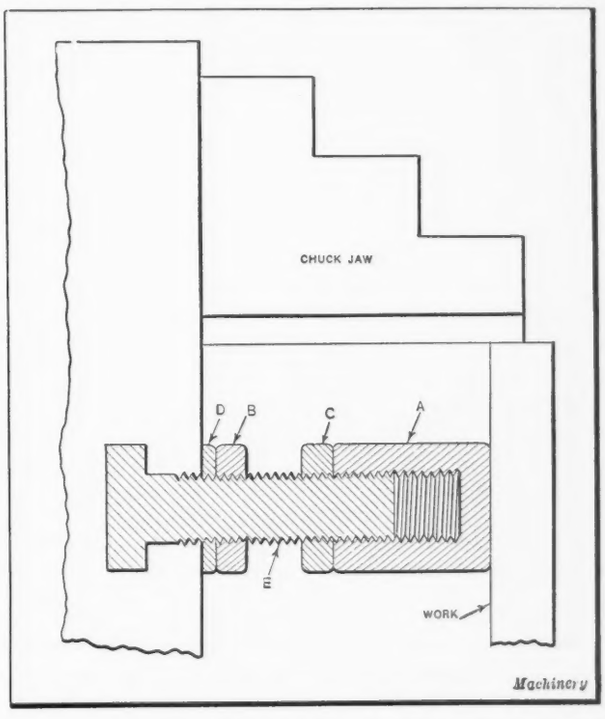
When the dividing head is used, a hole is drilled in the center of the work to permit it to be mounted on one end of an arbor, where it is held in place by a nut. The other end of the arbor is then clamped in the collet chuck of the indexing head. If it is not permissible to drill a hole in the work, a short arbor is soldered to the piece. This method of employing a dividing head has been found very satisfactory for grinding threading tools at one setting.

External and internal center gages, when the latter are made in two parts, can be ground at one setting by employing the dividing head. In fact, a large variety of rectangular and angular shaped pieces can be ground quickly and accurately by indexing the work in the dividing head to bring the different surfaces into the proper position for grinding. The indexing head may be held on the magnetic chuck or clamped to the grinder table. In general, work that can be held in the indexing head for milling can also be held in the same way for grinding.

Philadelphia, Pa. CHARLES KUGLER

ADJUSTABLE WORK-LOCATING STOP FOR CHUCK

A set of four adjustable stops made like the one shown in the accompanying illustration will prove a great time-saver in machining duplicate pieces that are required to be accurately faced on both sides. Stops of this kind are inexpensive to make and consist merely of a fine threaded bolt



Adjustable Stop for locating Work in Chuck

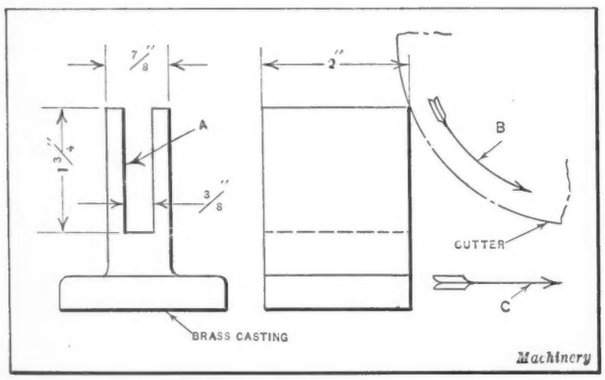
having a threaded sleeve *A*, lock-nuts *B* and *C*, and a washer *D*. The lock-nut *B* is used to secure the bolt *E* to the chuck. After the sleeve *A* has been set to the required height, it is locked in place by tightening nut *C*. The lock-nuts and sleeve are made from 1¼-inch hexagonal cold-rolled steel, and are casehardened. A set of longer sleeves may be made up for use in cases where the regular sleeves are not long enough to locate the work in the required position. Each of the four stops should, of course, be carefully located at the proper distance from the gripping face of its respective chuck jaw before adjusting the sleeves *A* to true up the work.

Ontario, Cal. CHARLES HOMEWOOD

Questions and Answers

MILLING A SLOT IN A NARROW CASTING

J. A. H.—A 3/8-inch slot *A* is required to be milled in 100 brass castings like the one shown in the accompanying illustration. Considerable difficulty has been experienced in



Milling Slot in Narrow Casting

preventing the walls at the sides of the slot from being spread apart during the milling operation. Is there any method of preventing this trouble and still maintaining a good rate of production?

ANSWERED BY S. W. BROWN, PAWTUCKET, R. I.

The milling machine is set up in the same manner as for milling an ordinary slot except that the cutter is run in the direction indicated by arrow *B*, and the table is fed in the direction indicated by arrow *C*. When running the cutter in the direction indicated by the arrow, any backlash is likely to cause the cutter to catch unless the table gib is adjusted to a rather tight fit. In some cases, it is necessary to provide a counterweight that will hold the table back or take up the backlash in the table feed-gears. A cutter of coarse pitch is preferable, and laundry soap applied to the cutter while it is running serves as an excellent lubricant for work of this kind.

REMOVING BURR FROM CAP-SCREWS

W. A. C.—Will you kindly describe the best method of removing the burr left by the slotting machine on 7/16- by 3/4-inch round-head cap-screws?

A.—One prominent screw products company states that the best method of removing the burr left on cap-screws by the slotting operation is to grind it off with a fine-grain emery wheel which will leave a smooth finish. It is the experience of this company that if the cutters are kept sharp, the burr will be very light and only a slight touch of the grinding wheel will be necessary.

Another method, employed by a manufacturer of hardware, is to tumble the screws after they have been slotted and then shave the heads in a special shaving machine.

INK FOR MARKING BLUEPRINTS

H. L. M.—I have often had occasion to make changes or notes on blueprints, and have experienced some difficulty in obtaining a satisfactory ink for this purpose. Can anyone give the name or the composition of an ink that will make clear distinct lines on blueprints?

ANSWERED BY MARTIN H. BALL, WATERVLIET, N. Y.

The writer has found that ordinary red writing ink with a little sal soda added will give clear distinct marks on blueprints. Very little sal soda is needed. Different grades of ink require different amounts, the right mixture being determined by adding the soda, a few grains at a time, until the ink begins to spread the least bit as it dries. A bright vermillion can be produced, which has the advantage of being visible as soon as it is placed on the blueprint.

INTERCHANGEABLE MACHINE PARTS

W. M.—When machine parts are said to be interchangeable, does this mean that all parts are so nearly alike that they will interchange without any fitting whatever, and is such interchangeability supposed to be maintained as long as machines of a given size or model are manufactured?

A.—There are several degrees of interchangeability in machinery manufacture. Strictly speaking, interchangeability consists in making the different parts of a mechanism so uniform in size and contour that each part of a certain model will fit any mating part of the same model, regardless of the lot to which it belongs or when it was made. However, as often defined, interchangeability consists in making each part fit any mating part in a certain series; that is, the interchangeability exists only in the same series. Selective assembly is sometimes termed interchangeability, but is merely assembly without fitting. It is used where close work and good fits are desired, and consists in selecting by trial the internal members, and assembling them with the external members so as to limit the freedom of fits, still allowing a reasonable tolerance in machining.

It will be noted that the strict definition of interchangeability does not imply that the parts must always be made without hand work, although that is usually considered desirable. It does mean, however, that when the mating parts are finished, by whatever process, they must assemble and function properly, without fitting individual parts one to the other.

CHINESE ALLOYS

C. R. M.—Will you kindly give the composition of the metals referred to as Chinese bronze and Chinese copper?

A.—There are a number of alloys known as Chinese bronze, Chinese copper, etc. These alloys have somewhat varying compositions. Chinese bronze, according to one formula, contains 83 per cent of copper, 10 per cent of lead, 5 per cent of tin and 2 per cent of zinc. Chinese white copper contains about 40 per cent of copper, 32 per cent of nickel, 25 per cent of zinc, and 3 per cent of tin. The metal used for Chinese gongs contains 81 per cent of copper and 19 per cent of tin, which is practically the same composition as that used for bell metals, which has 80 per cent of copper and 20 per cent of tin.

PRINCIPLE OF AQUOMETER

G. R. M.—What is an "aquometer"?

A.—The aquometer, more generally known as a pulsometer, may be defined as a steam pump which acts partly by direct steam pressure and partly by vacuum. It has two working chambers into which the steam is alternately admitted. A partial vacuum is formed by the condensation of the steam and water which rush into the chamber on account of the vacuum thus formed. When the chamber is full of water, the valve opens, steam enters again, and forces the water out into the delivery chamber, the steam condenses as before, causing the inflow of another supply of water, and the cycle is repeated. Two chambers are provided so that one is filled while the other is discharging.

Measuring Gear Teeth*

By J. L. WILLIAMSON, Research Engineer, The Fellows Gear Shaper Co., Springfield, Vt.

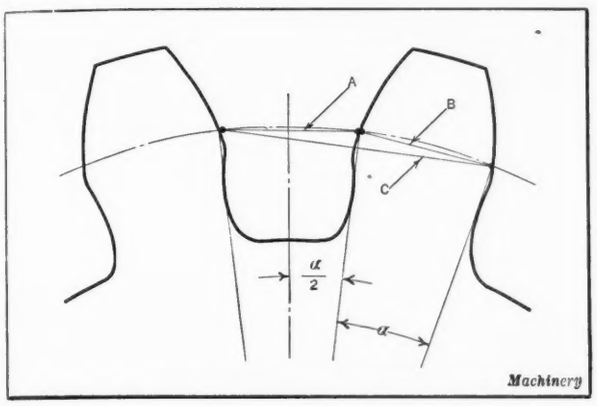


Fig. 1. Chords that are generally measured in checking Gear Teeth

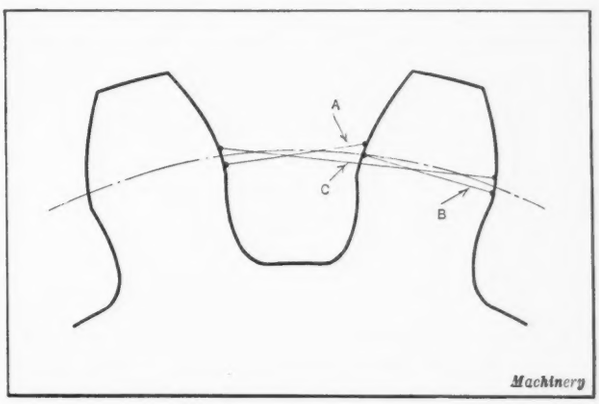


Fig. 2. Dimensions often, though erroneously, measured

THE subject of measuring gear teeth has been so thoroughly covered in the past that the so-called conventional methods are familiar to all gear makers and to many users of gears who are not engaged in the manufacture of them. The object of this article is to discuss some of the dimensions that are usually inspected, to indicate some of the difficulties that are encountered, and to suggest means of overcoming them.

The relation between the circular pitch, the tooth thickness, and the space width is so definite that it would seem impossible to find a discrepancy between these measurements; yet, very often they do not agree. When we refer to these dimensions, we usually mean the chords subtended by the arcs instead of the arcs themselves, as shown in Fig. 1.

It can be seen that a definite trigonometric relation exists and that if we were to make actual measurements, no discrepancy should be found. As a concrete example, let us consider a 15-tooth, 3-pitch gear. Assuming the space to be 0.004 inch too wide, the circular pitch chord should be 0.00394 inch too long. The difference is only a little over 0.00006 inch, and, because most testing machines will not indicate so slight an error, we should probably say that the 0.004 inch found in the space width was also found in the circular pitch.

Usually, however, we do not make actual measurements, but instead we check the variation in tooth thickness, space width, and circular pitch by taking relative readings. We set our fixture for checking the thickness of teeth near the pitch line. Another setting is required for the space width, which is also taken at a point near the pitch line. Then still another setting is required for a comparison of the circular pitches on one side of the teeth, and a slight change-over of the machine for checking the other side. These readings are also taken in the vicinity of the pitch line. When we have finished, perhaps we have measured the lines indicated in Fig. 2.

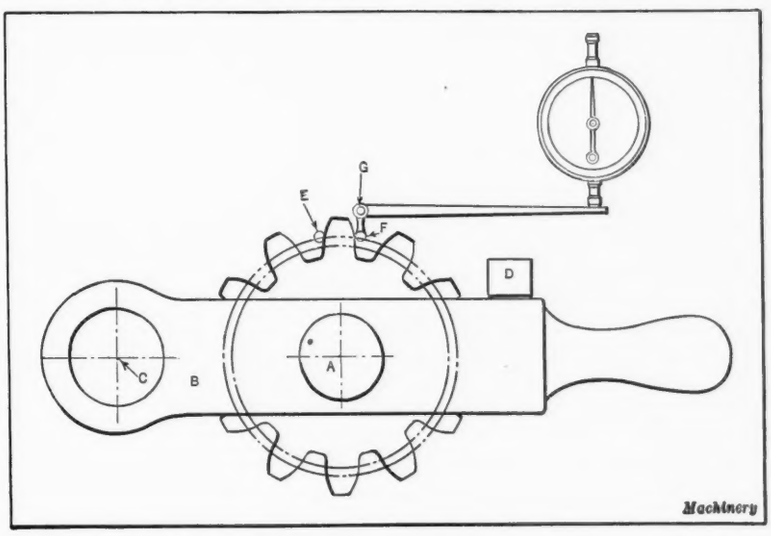


Fig. 3. Measuring Gear Teeth at a Constant Distance from the Center of the Hole

It is apparent that effort spent trying to compare these readings would only be wasted, and yet the values for each dimension taken separately tell us much about the physical characteristics of the gear. Let us consider some of the factors that have entered into our measurements and find the reason for the conditions indicated.

Tooth Thickness and Space Width

The thickness of a tooth is frequently measured from the top by the use of a templet or a tooth caliper. It can readily be seen that the outside diameter, its concentricity with respect to the bore, the number of teeth, and the pitch, all affect this measurement and make it necessary to introduce certain correction factors. Sometimes these factors are very simple and can be safely used, but more often they are due to such a complex relation that perfect correction is almost impossible.

Another method of checking tooth thickness or space width makes use of a micrometer fitted with V-blocks to represent rack teeth or spaces. These attachments are made to the correct pressure angle and of such thickness that a normal reading gives the diameter of the pitch circle. This method also has certain disadvantages, because a wide space opposite a narrow space could show the correct overall dimension, without indicating the errors. In addition to this, if the involutes were not correct, the measurement would not equal the pitch diameter, notwithstanding the fact that the spacing might be correct.

The practice of measuring these dimensions at a constant distance from the center of the hole eliminates many

*Paper read before the fall meeting of the American Gear Manufacturers' Association at West Baden, Ind., October 3, 1925.

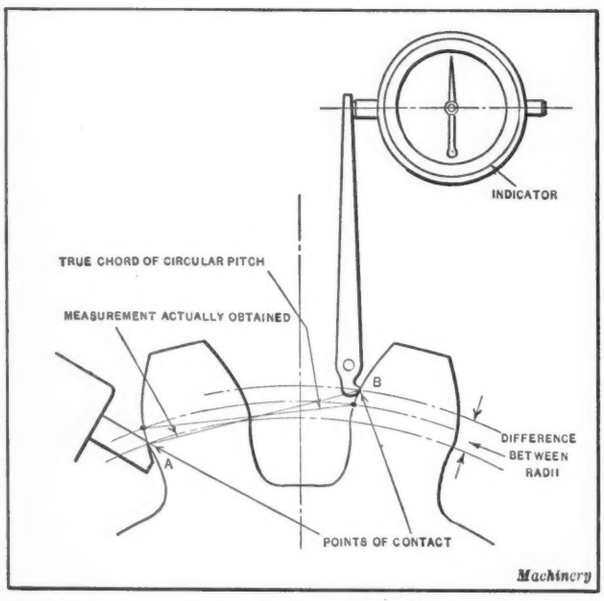


Fig. 4. Error in measuring Circular Pitch due to One Measuring Point being on One Circle and the Other Point on Another

of these objections. By referring to Fig. 3, it will be noted that the gear to be tested is mounted on stud *A* which is attached to handle *B*. These move about center *C* until the handle contacts with stop *D* and the tooth to be measured is between points *E* and *F*; *E* is in a fixed position and *F* is free to move about center *G*.

While this method may not be absolutely correct with only one of the points free to move, the correction is so slight that it can safely be neglected. The same fixture can be used to check the width of space by simply bringing *E* and *F* closer together so that they will enter a space with *E* contacting on one side and *F* on the other. The necessary adjustment should be made at *D* to allow *E* and *F* to touch the teeth at the pitch line, if the variations are to be compared with the circular pitch test.

Testing the Circular Pitch

The circular pitch is one of the most important dimensions to check. Sometimes an exact measurement is made on the pitch circle, but usually little attention is paid to this, and comparative readings are taken on any circle. This, in itself, would not be serious, were it not for the fact that very often one of the points is on one circle and the other point is on a different circle, as shown in Fig. 4. This gives a condition which is seriously affected by the profiles. We may get a relative spacing test, but the errors indicated may not be spacing errors. They may be variations in the involute. Perhaps this could be detected by checking at various points on the tooth: one near the pitch line; one near the top; and one near the bottom. If, however, the variations in circular pitch are to be compared with tooth thickness and space width readings, all measurements should be made on the same circle.

Checking Gears for Eccentricity

The eccentricity of a gear is often checked by placing a ball or master rack tooth in each space and noting the changes in the distance from the center of the bore to the points of contact. Obviously, this reading is affected by errors in spacing and profiles, which are usually indicated by abrupt changes, whereas eccentricity alone causes a regular movement of the needle from zero to the highest reading and back to zero. Doubtless the thing that should receive the greatest attention, if a ball is used, is its diameter. If the ball is so small that it contacts too near the bottom of the space, the movements of the indicator are very easily misinterpreted. By referring to Fig. 5, it will be seen that a slight spacing error will allow the ball to enter the space to a considerable depth, and the eccentricity of the gear will have very little effect on the indicator. Carried to the extreme, if the teeth had parallel flanks, and the diameter of the ball were the same as the width of the flanks, the slightest addition to this width would allow the ball to drop to the bottom of the space, notwithstanding the fact that it might be on the high side of the gear; see *B* and *D*.

In order that the eccentricity may have a greater effect on the indicator than errors in spacing, we should use the largest possible ball without danger of contacting on the corners or at points where the involutes have been relieved. The conditions at *E* and *F* should be compared with *A* and *B*, which latter show a ball in contact near the pitch line. It will be seen that the ball has dropped approximately twice as far at *B* for the same error in spacing.

The same general condition is present if a master rack tooth is used. Fig. 6 shows the effect of spacing errors on rack teeth of various angles. The conditions at *C* and *D* are very different from those shown in the previous illustration. The increase in space width has allowed the rack tooth to enter a little farther than at *B*, but it does not touch the bottom of the space. Fig. 7 shows a condition that is not always appreciated. The point of contact on the tooth surface changes with every variation in spacing, if a ball is used, but it does not change as the rack tooth moves in or out from the center of the bore. The line of action always passes through the center of the ball and is tangent to the base circle. As the ball changes its position with respect to the center of the gear, the angle of the line of action must also change. With a rack tooth, the line of action is always perpendicular to the side of the tooth, and since the side is straight, the angle of the line of action is constant.

The following conclusions may be drawn from the foregoing:

To check eccentricity, the points of contact should be as near as possible to the ends of the teeth.

To check spacing, the points of contact should be near the pitch circle.

Comparative readings cannot be obtained with different testing fixtures, unless the diameter of ball is the same on both machines.

Comparative readings cannot be obtained on different testing fixtures, unless the pressure angle of the rack tooth is the same on both machines.

Sometimes a gear is tested for eccentricity by engaging it with its mating member without backlash and noting changes in the center distance as the gears revolve. It is conceivable that the eccentricity of one might offset the

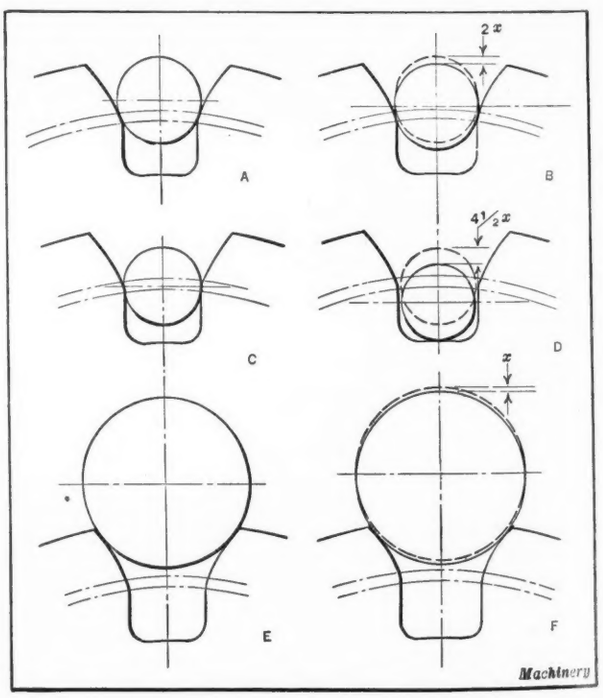


Fig. 5. Illustrations showing the Effect of the Use of Different Sizes of Balls or Cylinders for checking Eccentricity

eccentricity of the other. Often the second gear is a master of known proportions. While this is preferable, all changes in center distance are not entirely due to eccentricity, as the other teeth in the arc of action influence the movement of the free gear. This method is likewise affected by errors in spacing and profiles.

Normal Involute Pitch

The normal involute pitch is the length of the arc of the base circle between corresponding sides of adjacent teeth. If the involutes are correct, the distance between the profiles is the same on any straight line which intersects both curves and is tangent to the base circle. If this dimension is used to compare the spacing or profiles, the measurements should be taken at several points along the tooth surface.

There are involute testing machines, the designs of which are based upon the geometric properties of the curve. With these machines, it is possible to take very accurate readings of the profiles of an involute gear tooth from the base circle to the top, if the machines are sufficiently sensitive. The curve is not affected by errors in tooth thickness or spacing for the reason that an involute can be generated through any point on the base circle. Because of this fact, we should have more confidence in this reading than any of the others.

Qualifications of Inspectors of Gears

The few cases cited above are sufficient to suggest the need for highly trained inspectors. Some of the essential qualifications are:

1. *Thoroughness*: It it not sufficient that the inspector be highly skilled in the use of inspection equipment; he should also have a desire to understand the theories which form the basis of his practice.

2. *A receptive mind:* Many valuable suggestions are received from unexpected sources. Ideas should be carefully considered before they are condemned.

3. *An analytical mind:* No new method should be adopted before its value is proved.

4. *Creative ability:* He should be able to develop new methods and improve old ones.

5. *Keen appreciation:* Errors are possible with the best of measuring fixtures. This condition will continue just as long as the human element is involved.

6. *A cooperative spirit:* It is his duty to see that the plans and specifications of the engineering department are followed in the process of manufacture.

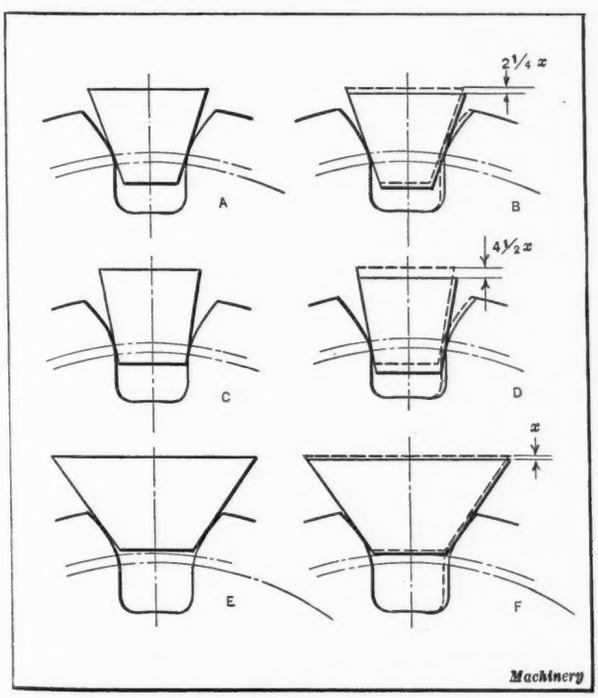


Fig. 6. Effect of using Different Angles of Master Rack Tooth for checking Eccentricity

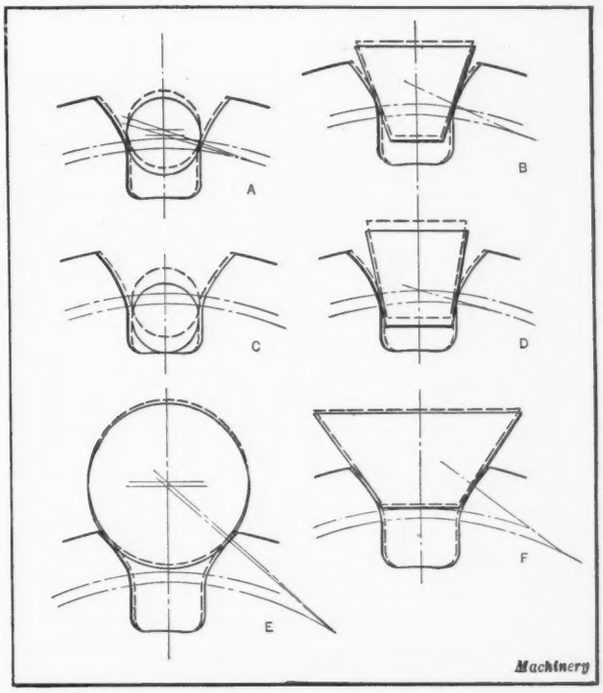


Fig. 7. Illustration indicating how the Point of Contact varies when a Ball or Cylinder is used, but remains Constant when a Rack Tooth is employed

7. *An exacting mind:* Limits which have been established by the engineering department must not be exceeded.

8. *A tactful sense:* Inability to obtain correction of work without antagonizing foremen retards production and destroys morale.

Inspectors, in general, usually possess most of the qualifications mentioned and those that are not prominent can easily be developed if careful attention is given to the requirements. It might follow that a well planned system of training for inspectors is the logical solution, and there are many arguments that could be presented in favor of it. As long as the human element plays such a prominent part, we should first raise the standard of our inspectors if we would raise the standard of our inspection.

However, we must not make the mistake of believing that the inspector can be of the greatest value to any concern through his efforts alone. He must have the confidence and assistance of the management. Direct lines of responsibility must be established and maintained. Since the inspector's work is to see that the engineer's directions are carried out, it naturally follows that the chief inspector should be directly responsible to the engineers. He should obtain their decision on questions concerning quality of product or application of general limits to special classes of work.

This, of course, applies to any line of inspection, but the degree to which it should be carried depends upon the class of material which is being produced. Gear-cutting methods have been developed to the point where precision work can be obtained on a quantity basis. Manufacturing limits should be based upon actual operating conditions. It is not infrequent that gears which have passed inspection are found unsatisfactory for service, while gears which will not pass inspection, give no trouble when assembled.

* * *

STANDARD HOSE CONNECTIONS FOR TORCHES

A circular illustrating and describing standard hose connections for welding and cutting torches and regulators has been published by the Gas Products Association, 140 S. Dearborn St., Chicago, Ill., and may be obtained from the association upon request. These standard hose connections have been developed by the standardization committee of the Gas Products Association, and approved by the International Acetylene Association and the Underwriters' Laboratories. They have also been adopted by leading manufacturers.

The Machine Tool Industries

By J. R. KRAUS, Vice-president and Executive Manager, The Union Trust Co., Cleveland, Ohio

THE most startling advance made in the last half century has been along the line of invention, manufacture, and the adaptation of machinery for a variety of purposes. There is one particular line of industry that has been of basic importance in this progress and without which development of mechanical processes would have been impossible. That is the machine tool industry. Without machine tools, it would not have been possible to apply any of the principles of electric power, gasoline-propelled vehicles, radio, telephony, or any other modern inventions.

The Basic Importance of Machine Tools

Though in actual size the machine tool industry appears small compared with many other industries, it nevertheless is most vital to them all. Possibly the only other industries that are as essential are those that have to do with the development of our natural resources, and even those industries are dependent upon the machine tool.

Imagine, if you can, that all machine tools have been wiped out of existence, without possibility of replacement. It would be but a matter of months before all other industries would die for lack of repair or replacement of the physical means with which to carry on; and so, though the machine tool industry employs normally only about 50,000 people, it is of paramount importance to every business.

This fact is stressed because men engaged in other lines of business—men who deal with the product itself rather than with its production—often find it difficult to see the essential relationship between their own success and prosperity and the success and prosperity of the machine tool industry. A man selling calculating machines, dealing with auditing and bookkeeping departments, may not think of the machine tool industry from one year's end to the next—and yet it is essential to his very livelihood.

Failure to sense the essential nature of machine tools is particularly evident on the part of men engaged in the marketing and financial end of many manufacturing businesses. These men, when in control of industrial enterprises, are frequently very conservative in spending money—an attitude creditable enough in itself, but which sometimes defeats its own purpose, because the use of obsolete or worn out machine tools may actually cost a plant much more in the long run than the outright purchase of new machines of a more efficient type.

Improved Equipment Produces Profits

In fact, looking at it from a positive rather than a negative point of view the purchase of new machinery may add decidedly to the net profits of a plant, and this increase in net profits may be quite definitely figured in advance. On the basis of standard production throughout the year, a number of estimates of specific replacements give surprising figures. For instance, in a certain factory one replacement reduced the time on one operation from 43 minutes to 18 minutes. The investment for the new machine was $4100. The saving per year—that is, the actual addition to the net profits per year—was $3494.40, making the annual return on the investment equal to 85.2 per cent.

It is much more constructive to view replacements from the standpoint of an increase in future profits than it is to view them from the standpoint of decrease in present costs—although, of course, the facts remain the same, no matter from which angle replacements are viewed.

It is only natural that men whose experience has been in the financial and sales end of the business should be unable to see why a machine, to all appearances sturdy and solid, which has been in operation for, say, fifteen or twenty years, should not continue to operate for another fifteen or twenty years. Interested primarily in getting immediate returns from the business, these men dislike to face the problem of replacement of machinery with its attendant expense—and so they blue-pencil contemplated expenditures in this line, shutting their eyes to the consequences. This attitude is generally due to a lack of actual experience in the shop, with the consequent inability to understand the true situation.

The Manager Knows that Automobiles Become Obsolete but Believes that Machine Tools do not

The manager of a plant does not maintain the same attitude toward his automobile or his radio, or any other piece of machinery with which he is familiar by personal use, that he maintains toward machine tools. When he purchases an automobile, he takes it for granted that in three or four years it will be obsolete. He does not think that simply because the automobile may continue to run for four or five years more, it is worth while retaining. In the case of a radio, he knows that a two-year old set has become obsolete, and that replacement by a newer and better type is necessary to effect the results he desires; and yet, when he comes to machines such as milling machines, planers, and lathes, he is inclined to say "No" to the first suggestion of replacement, regardless of the age or the degree of obsolescence of the machine.

This attitude, together with a number of factors within the industry itself, has made the machine tool industry particularly susceptible to the ups and downs of business—more so probably than should be the case with an industry so basic in its nature. One factor within the industry has also aided in placing it on an unsatisfactory business foundation. This arises largely from the very nature of the work that the industry performs. Inventive genius is essential to the machine tool industry—and inventors are no more financial geniuses than financial geniuses are inventors. The fact that men in the trade must be highly skilled scientifically and technically is perhaps the reason that they have suffered in many cases through inability to finance and distribute efficiently. The machine tool man has been a better inventor than he has been a business man. The machine tool industry has not always insisted upon sufficient profits to carry it through ups and downs, good years and lean years.

The Real Value of Machine Tools

The intelligent purchaser of a machine tool views its price in the light of its usefulness and the inventive genius that has gone into its construction, rather than solely on the per pound basis. Brain work cannot be sold by weight, and the machine tool industry should secure an adequate return on the scientific and mechanical skill and experience necessary to the manufacture of its product.

A Machine Tool is an Investment, Not an Expense

Let me urge, too, that the buyer of machine tools should regard them as an investment rather than an expense. In many industries, it is customary, and often considered good policy, to charge off the entire cost of a new machine tool within a year. While this may be entirely justified in the case of office fixtures and furniture, which do not enter actively into production, such stringent financial attitude should not be adopted toward machine tools. On the books

of the company machine tool costs might better be spread over a period of years commensurate with their life and usefulness. Such a plan might make the attitude of the purchaser toward the cost of new machines much more lenient and equitable.

Method of Charging Depreciation and Taking Care of Replacements

There is another matter that must be taken into consideration in considering the depreciation account. Suppose depreciation on machine tools is figured on the basis of 10 per cent per year, thus spreading the cost of machine tools on the books of the company over a longer period of time, as suggested in the last paragraph. In such a case, it might be borne in mind that this depreciation is actual and not theoretical, and the depreciation account should be carried as an actual cash account, and not merely as a book item.

Let us assume that a plant starting out with $200,000 worth of new machinery in a certain year should plan to charge off 10 per cent a year for depreciation and at the end of seven years has charged off 70 per cent of the original cost of this machinery—that is, $140,000. The question is—does this company, at the end of the seven years, have $140,000 in cash set aside to meet replacements? Unfortunately, this is not usually the case. The depreciation reserve exists only upon the books of the company and is not provided for in a reserve bank account or in securities.

Of course, this is purely a hypothetical case, given merely for purposes of illustration. Few plants start operation with all new machinery—and few going concerns actually setting aside cash to offset depreciation would allow all of this cash to remain unspent over a period of seven years. Instead they would gradually begin spending this cash for new machinery, meeting depreciation and making replacements from time to time as demanded. In any event the 10 per cent depreciation allowed for would be offset either by a cash reserve or through actual replacement by new machinery. But if a company's depreciation account is merely a book account, it will soon become only too evident that the depreciation "charged off" has been utterly meaningless, and the company will be face to face with the task of raising cash immediately for the purchase of new equipment. Only by offsetting depreciation by either a cash reserve or the steady replacement of old and obsolete machinery by new, will a company be in a position where it will not have to resort to extraordinary or outside financing to cover new equipment.

In other words, although it may not seem advisable to charge off the entire cost of new equipment as an expense during the year in which it is bought, as this cost should properly be distributed over a considerable period of years, nevertheless, depreciation must be figured as actual and not theoretical, and a reserve fund should be set up to allow for replacements when needed. In the long run, an attitude such as the one outlined would benefit the purchaser as well as the entire machine tool industry.

* * *

NUMBER OF MOTOR VEHICLES IN USE

According to a report recently issued by the British Ministry of Transport, the number of motor vehicles in Great Britain is now nearly 1,400,000, an increase of 550,000 in five years. Of these motor vehicles, 533,000 are privately owned passenger cars, 518,000 are motorcycles, and about 230,000 are trucks, the remainder being taxicabs. There is approximately one motor vehicle in England to every thirty inhabitants, if motorcycles are included. Without the motorcycles, however, there is only one car for every fifty people. In the United States there is one for every six or seven inhabitants. In Germany, there is one automobile for every 272 inhabitants; in France, one for every 69; in Japan, one for every 2700; in Russia, one for every 9000; and in China, one for every 40,000. The number of motor vehicles in the United States in 1924 was approximately 83 per cent of the world's total.

ARE YOU GUARDING AGAINST CANCELLATIONS?

Now is the Time to Do It

By ERNEST F. DU BRUL
General Manager, National Machine Tool Builders' Association

With the increased business that has lately been coming, it is well to keep in mind the question of cancellations. In every period of active business, a good many people overestimate their machine tool requirements and for that matter, some machine tool builders overestimate their own ability to produce machine tools within a given length of time. If the deliveries are too long delayed, and if the user finds that his own demand has slipped out from under him, conditions are created that are productive of cancellations.

Of course, the machine tool builder should always be very careful in estimating his time of delivery, and not quote deliveries that he has no reasonable hope of fulfilling. This is only square business. If he does not do this, he has only himself to blame if delayed orders are cancelled, because he himself has broken the contract. On the other hand, the machine tool builder who has carefully estimated his time of delivery and has kept up with it, but has been made the victim of the over-enthusiasm of his customers in estimating their own needs, is put to a great loss if he accepts a cancellation of an order taken in good faith.

There is a common impression that the greatest loss through cancellations of orders occurs in the field of special machinery. This is erroneous. The fact is that in 1920 and 1921, the larger proportion of the losses fell upon manufacturers of standard lines. These manufacturers assumed that a cancelled order could be replaced by another one, and woke up too late to the fact that new orders were no longer coming through. Consequently, they found themselves with a heavy inventory that had been provided to carry out orders that later were cancelled.

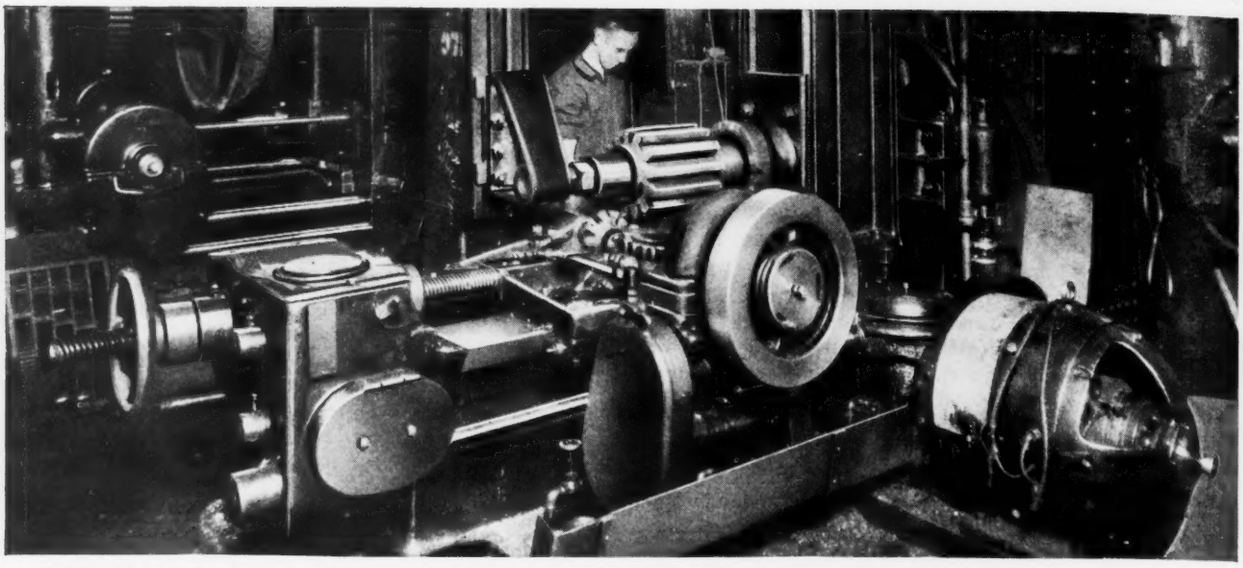
The only safety for the machine tool industry lies in impressing on the buyers of machine tools that when they order the machines, they make a contract, and that that contract can be cancelled only by mutual consent and on prearranged terms. The larger units of the industry, particularly, can perform a tremendous good for themselves and for the whole industry by standing firmly on their rights in this matter of cancellations, and thus educating customers of the industry to the fact that an order is a contract. Only by recognizing the conditions in advance and providing against them, will the evils of cancellations be avoided.

* * *

WAGES IN DIFFERENT COUNTRIES

A survey of wages in different countries has been made by the International Labor Office of the League of Nations. In this survey, wages are measured in terms of what they will buy. Fifteen leading industrial cities in as many different countries were chosen for comparative purposes. The purchasing power of average wages in London, England, was used as a base and assumed to equal 100. The information used in establishing the wage standard included average wages for fourteen skilled trades and several unskilled trades. The purchasing power of wages was ascertained by comparing rent and the cost of seventeen items of food.

According to the figures computed, it will be found that if the purchasing power of a day's wage in London is equal to 100, Philadelphia (chosen as the representative city for the United States) ranks highest at 183; then follow Ottawa, Canada, at 148; Sidney, Australia, at 140; London, England, at 100; Copenhagen, Denmark, at 97; Amsterdam, Holland, and Oslo (Christiania), Norway, between 80 and 90; Stockholm, Sweden, at 74; Berlin, Germany, and Lodz, Poland, between 60 and 70. Brussels (Belgium), Madrid (Spain), Milan (Italy), Prague (Czecho-Slovakia), and Warsaw (Poland) rate from 50 to 60. The lowest city listed is Lisbon (Portugal) at 32. Vienna (Austria) and Rome (Italy) are both below 50.



A Self-supporting Apprenticeship System

Features of Apprenticeship System Conducted by the Marion Steam Shovel Co., Marion, Ohio

MOST shops that conduct apprenticeship courses do not have exact records of the cost of this training, and, therefore, the management does not know whether the system pays for itself or not. Usually the director of the system is sure that the work done by the apprentices covers the cost, but it is necessary to have definite figures to prove this. Apprenticeship courses should not be carried on with the idea of making them self-supporting, because when costs are watched too closely, the apprentices are not likely to receive complete training. It should be kept in mind that the value to the shop and to the community of the skilled men graduated from the courses is inestimable. Nevertheless, it is a satisfaction to know that an apprenticeship system does pay for itself, and that it is not necessary to spend a great amount of money and effort before worthwhile results can be realized.

Monthly figures, compiled by the regular cost accounting department of the Marion Steam Shovel Co., Marion, Ohio, prove that this company breaks even financially on the apprentice courses. At this plant there is no separate department in which the boys are given a preliminary training; they are immediately placed on a regular production machine in some department of the shop, and are transferred from department to department as they progress. In each department, they are assigned successively to the different machines to finish the work routed to those machines. In routing the work, no thought is given to the operator, the only consideration being the ability of the machine to perform the different operations required. In fact, the routing for the entire plant is done in one department by men who do not know who operate the different machines. This method insures that the apprentices receive complete training and enables the costs of the system to be conveniently calculated.

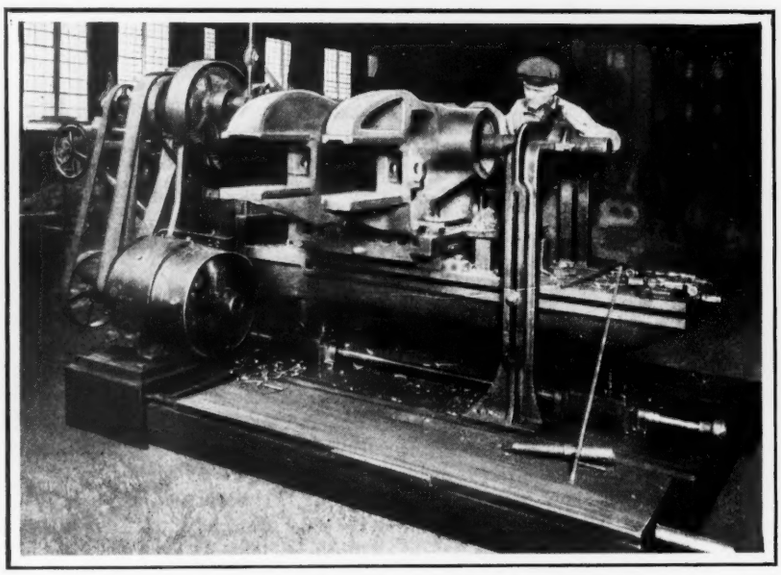


Fig. 1. Third-year Apprentice running a Horizontal Boring Machine on which he has set up Two Heavy Castings and the Necessary Tool Equipment

How the Costs are Figured

Fair wages are paid to the apprentices, but, as in any other shop, the rates are somewhat lower than those paid to men or boys who are operating similar machines but are not learning a trade. On the basis of the work actually performed, it has been estimated that the apprentices, taken as a whole, are worth a wage equal to the average rate paid in the various departments, because the apprentices turn out as much work as the average man. But, as the average rate paid in each department is higher than the apprentice rates, for every hour an apprentice spends in a given department, the company saves the difference between the average rate of that department and the wage paid the apprentice. In figuring the costs of running the apprenticeship system, this difference is credited to the system.

On the other hand, should it happen that an apprentice takes six hours to do a job that a regular machinist could turn out in four, two hours at the average rate is charged against the appren-

tice department and also the regular shop overhead cost for two hours of a man's time. Then, too, for every hour that a boy spends in school receiving instruction in shop mathematics, mechanical drawing, etc., the apprentice rate for one hour is charged against the apprenticeship system. Even with all these charges, the difference between the amount of money paid the boys and the regular men for the same kind of work is sufficient to pay all costs of the apprentice department, including the salaries of the director, his secretary, and three part-time instructors. These results are obtained without any loss in the extent of the training.

Apprentices who have not graduated from high school, start the course at a wage of 23 cents per hour, while high school graduates start at 27 cents per hour. These rates are periodically advanced until the last six months of the course, when all apprentices receive 48 cents per hour. When apprentices do better than meet the standard time on any job they are doing, they are paid for the full standard time and receive a premium the same as regular workmen. That is, if the standard time for the job is six hours and the apprentice performs the work in four hours, he is paid for the full six hours and receives a premium in addition. At present there are thirty-seven apprentices taking this course.

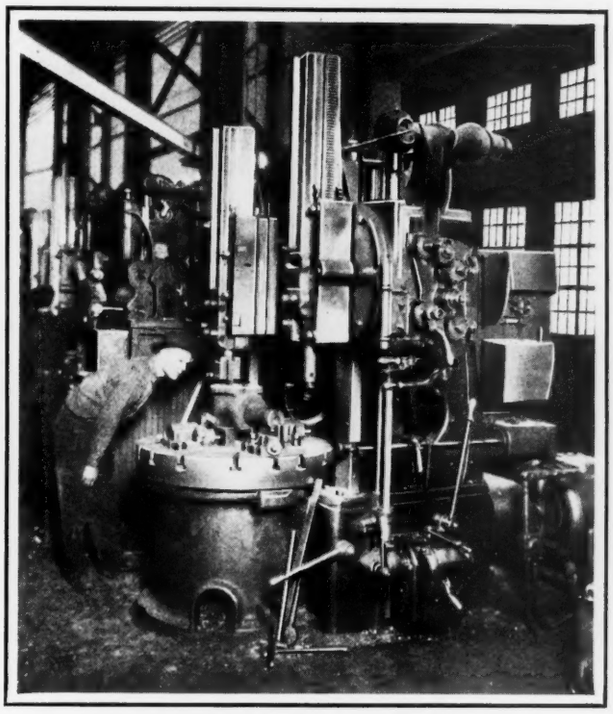


Fig. 2. Typical Operation performed by a Third-year Apprentice on a Vertical Boring Machine

Outline of the Courses Taught

Eight trades are taught in this plant for training machinists, toolmakers, patternmakers, draftsmen, foundrymen, blacksmiths, boilermakers, and electricians. For each boy who is not a high school graduate, the course consists of eight periods of approximately six months each. The actual basis is 1320 hours of work for each period. For the high school graduate, the course is two periods less than for the non-graduate. All over-time work tends to shorten the course so far as the number of days is concerned, and when an apprentice shows unusual aptitude so that he forges ahead of his associates, he is credited with a certain number of hours at the discretion of the director of the system.

Out of every week each apprentice spends five hours in the school-room. Two of these hours are devoted to studying the mathematics essential to each trade; two to mechanical drawing; and one to the economics of industrial management. The subject of mathematics is taught in small groups of from four to eight, so that the boys who are quick to learn need not be held back by the slower ones. Each problem is of a practical nature and is given in terms used in the shop. The problems are multigraphed and bound in pamphlet form. For the machinist apprentices, this subject begins with ordinary arithmetic and ends with strength of materials. Mathematics and mechanical drawing are taught by three regular employes of the plant who each devote a few hours per week to this work. One of these part-time instructors is a graduate apprentice.

The boys following the course in mechanical drafting receive more instruction in drawing than two hours per week, as their shop work consists almost entirely of this subject after they have spent two years in the machine shop, foundry, and pattern shop.

In addition to the types of apprentices mentioned, there are part-time apprentices who alternately spend one week in the shop and one week at high school. When these boys graduate from high school, they have but two years left in their apprenticeships. For convenience, the work of these boys is planned in pairs, so that when any boy is at school, someone is taking his place in the shop.

Teaching the Economics of Industrial Management

One of the important features of this apprenticeship system is the stress laid on giving the boys a real conception of the economic principles on which industrial management is based. There is a tendency for shop men to compare the costs of materials and labor with the selling price of a product and assume that the company is making enormous profits, forgetting entirely the costs of shop overhead, selling, advertising, etc. Also there are some shop men who contend that the only reason for automatic labor-saving machines is to throw men out of work, whereas the object always is to increase production and reduce costs in order better to meet competition and to enable the producer to offer his product at a price more attractive to the purchaser. It is well at the very beginning to direct the boys' thoughts along these lines into the proper channels, and this attempt is made in the period devoted each week to teaching the economics of industrial management.

In connection with the course on economics of industrial management, the director gives many important facts concerning the natural

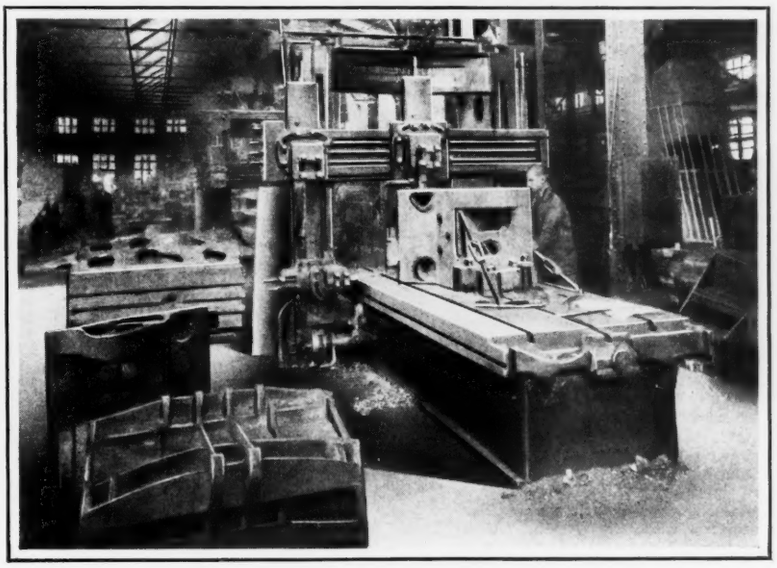


Fig. 3. Illustration showing Typical Examples of Work assigned to a Planer operated by a Second-year Apprentice

resources of our country, our manufactured products, the development of better methods of production, costs, financial organization, and the human element. Through class discussion, fundamental economic principles are implanted in the minds of the boys. The text-books used in teaching this subject are "Industry and Trade," by Bishop and Keller, and "Our Economic Organization," by Marshall and Lyon.

More About the Work in the Shop

In their shop work, new apprentices are immediately assigned to machines without first receiving instruction in filing, etc., and immediately become productive. Their only instructors in the shop are the regular foremen, which makes the boys realize that they are a definite part of the manufacturing division. It has been comparatively easy to get the foremen to cooperate in this work because they are not tied to any fixed schedule, and several of them have shown their interest by voluntarily preparing booklets containing questions relating to representative machine tools. These booklets average ninety questions, dealing with the construction and operation of the machines, and the boys are expected to answer them correctly when they have completed their assignments to those machines. The apprentices obtain a varied experience in this plant, because of the large range in the size of the work, and because of the fact that work is assigned to their machines without the routing department knowing that an apprentice is the operator. He often works on castings weighing up to 3 tons.

The accompanying illustrations show typical operations carried out by the apprentices. In the heading illustration, a second-year apprentice is shown cutting a large spur pinion in an automatic gear-cutting machine, after spending about three weeks on the machine. On all machines the apprentices are required to set up the work and the tools.

Fig. 1 shows a boring operation on two large castings mounted on a horizontal boring machine. The bores are 9.6275 inches in diameter and must be true within + 0.000 and — 0.001 inch. The boy handling this work is a third-year apprentice. In Fig. 2 is shown a typical operation performed on a vertical boring machine to which apprentices are assigned near the beginning of their third year. A planer set-up is shown in Fig. 3, the operator, in this case, being a second-year apprentice. About 75 per cent of the machine shop apprentices' work is to set time rates. These apprentices serve about eight weeks in the foundry, two of which are spent in making cores, two in setting cores, and four in molding. Patternmaking and drafting apprentices spend considerably more time in the foundry.

I. B. Shoup*, Director of the Apprenticeship System of the Marion Steam Shovel Co.

The Work of the Director

This entire apprenticeship system is conducted by a director, his secretary, three instructors who each serve a few hours per week, and the department foremen, who give only a small portion of their time. The excellent results obtained with this small personnel show how well organized the system is. The director receives all applications for apprenticeships and interviews the applicants; issues orders for the transfer of the boys through the different departments; teaches the subject of economics of industrial management; and supervises the work in the shop and school-room. In addition, he looks after twelve college graduates who are being given a shop training to fit them for the sales and engineering departments. The organizer and director for the last four years has been I. B. Shoup, to whom credit is due for the development and success of the system.

* * *

Some time ago the Bureau of Standards, Department of Commerce, brought out what is known as an "electric telemeter" for measuring changes in the length of structural members produced by variations in the load upon the structure. The operation of the telemeter depends upon the variations in resistance to the passage of an electric current of a stack of carbon disks. This is the same principle as that employed in the microphone in the transmitter of the telephone. There is, therefore, nothing new in the principle employed, but the bureau was the first to apply this principle to a precision measuring instrument. Recently a new use has been found for this device in the measurement of the strains in mass concrete. For this purpose, a special cartridge has been designed which houses the stack of carbon disks, and which is embedded in the concrete at the point where the measurement is to be made. Wire leads extend to the surface and are carried to some convenient point where the indicating instruments are placed. These instruments are calibrated to show any deformation in the concrete due to loading. The instrument will shortly be used in an investigation which is to be carried out by a special committee sponsored by the Engineering Foundation, on a dam which is to be erected at Fresno, Cal.

* * *

According to an article on the market for American machine tools in Czecho-Slovakia, published in *Commerce Reports*, there are in that country approximately 2100 shops employing 133,000 men, which can be classed as potential buyers of machine tools. Of this number 90 would be classed as large, according to American standards; about 300 are medium-sized; and the remainder are small shops having only a few machines. The machine-building industries that offer the best opportunities for American machine tools are those manufacturing agricultural equipment, sugar-making machines, brewing machinery, equipment for distilleries and starch factories, locomotives, railway cars, automobiles, and electrical equipment.

* * *

THE ENGINEER'S VISION

After all, works of the engineer's creation are but the means to an end, not the end itself. They contribute to the well-being of humanity, and man is more than a physical being. Surely, the engineer has a duty to perform in addition to the development and care of material things, wonderful as they are. I do not like to think that the engineer can see only the steel and masonry structure he designs and builds. I hope he has a vision of what it is built for, as the architect of the Middle Ages had of the great cathedral he erected, and that the spiritual, moral, and esthetic sides of life have a great value to him.—*Robert Ridgeway*, President, American Society of Civil Engineers.

*I. B. Shoup, organizer and director of the apprenticeship system described in this article, was reared in Forest County, Pa., and received his elementary education in the public schools. He prepared for the teaching profession at the Clarion State Normal School of Clarion, Pa., earning his way by working in machine shops and on railroads during the summers. After graduating, he became boys' work director at the Oil City (Pa.) Y. M. C. A., and two years later entered Allegheny College, Meadville, Pa., which he attended for one year. He then became principal of an elementary school in Newcastle, Pa., where he remained for six years, the last three of which he also served as director of vocational education in charge of night schools. During the summers he took special work in educational administration at the University of Pittsburg and Columbia University. His public school work so developed his interest in industrial education that he went to the educational department of the Westinghouse Electric & Mfg. Co. at East Pittsburg, Pa., in the fall of 1917 as director of trades apprentice instruction. After four years with the Westinghouse Co., he became connected with the Marion Steam Shovel Co., where he established the personnel and training work here described.

A BASIC ALLOWANCE AND TOLERANCE SYSTEM

By JOHN GAILLARD, Engineer,
American Engineering Standards Committee, New York City

An article on the "uni-bilateral" system proposed by Mr. Hindman in August MACHINERY (page 933) was commented upon by the writer in the October number (page 93), and a defense of the system by its author appeared in November (page 231).

In reply to the points referred to by Mr. Hindman, it may be best to check the principle of the system and the advantages claimed for it, on the basis of Mr. Hindman's statements in the November number, as contained in the twelfth, thirteenth, and fourteenth paragraphs, in which reference is made to the diagrams on page 93 of October MACHINERY. These diagrams refer to a case cited by the present writer as a concrete example, in which the tolerances on the mating parts are supposed to be ultimately increased, after the practical try-out of the product concerned has proved that this was allowable. Mr. Hindman calls such procedure "a mistake made in the first assignment of tolerances." On the contrary, the procedure referred to constitutes sound practice in the initial stage of manufacture of a new product, in case it should be desired to remain on the safe side in the first choice of the tolerances. It is well known that in work-shop practice it is easy to "loosen up," but difficult to "tighten up" on the tolerances, and no apology need be made for tentatively adopting closer tolerances than later prove to be necessary.

However, in whatever way this example be looked at, it has been shown by the present writer's diagrams and comments in the October number, that a problem of this kind does not cause any trouble to the user of the unilateral system. How is this case to be dealt with in the "uni-bilateral" system?

Mr. Hindman says, in part, referring to diagram *D* on page 93, October number: "The uni-bilateral identification for diagram *D* is $1.0010\ ^{+0.0010}_{-0.0020}$ for the hole, assuming that a 1.0010-inch reamer is to be used. For a 1-inch or standard reamer, the identification for the hole becomes: $1.0000\ ^{+0.0020}_{-0.0010}$.

In regard to this statement, it should be noted, first, that the hole represented by diagram *D*, has a nominal size of 1 inch, not of 1.0010 inch. To be consistent with the basic principle of Mr. Hindman's system, the uni-bilateral identification should therefore be $1.0000\ ^{+0.0010}_{-0.0020}$. In fact, where this principle is explained in the August number, Mr. Hindman says that "the tolerances for all holes are so divided that one-third of the tolerance is above and two-thirds below the *nominal* size" (page 934).

Mr. Hindman says that a 1.0010-inch reamer may be used. Is this to be called a "standard" reamer? The catalogue of a large tool manufacturer in the United States gives the "standard" chucking reamers as stepping up in nominal diameter by 1/32 inch; therefore, a 1.0010-inch reamer is a *special* one whose size lies between the 1-inch and 1 1/32-inch "standard" reamers. However, Mr. Hindman stated in his article (page 934, August MACHINERY) that one of the four "major and very important conditions" upon which his system is based, is the use of "new *standard* reamers as purchased." To be consistent, he should therefore refrain from having recourse to the use of a special reamer.

The latter part of Mr. Hindman's statement previously quoted refers to the use of a 1-inch or "standard" reamer. This alternative, however, is accompanied by two remarkable expedients. In the first place, the identification of the hole is changed. It is no longer written $1.0010\ ^{+0.0010}_{-0.0020}$, as in the case when a 1.0010-inch reamer is used, but $1.0000\ ^{+0.0020}_{-0.0010}$, although the limits remain unchanged. These are 1.0020 and 0.9990 in both cases. In other words, the identification of the limits varies with the size of the tool to be used; this is certainly a useless and confusing complication in a method of indication. In the second place, by using the identification $1.0000\ ^{+0.0020}_{-0.0010}$, and thus taking two-thirds of the tolerance above, and one-third below the nominal size, instead of inversely, Mr. Hindman turns the basic principle of his system upside down.

Mr. Hindman mentions that "this special condition is automatically dropped when a new design is made or a modification is made calling for different parts which are not interchangeable with the first parts, quite independently of any tolerance."

In discussing Mr. Hindman's system, it has been assumed that "the modern interchangeable plan of manufacture" was being dealt with, as mentioned in the second line of his article in the August number. It is therefore somewhat surprising to find that Mr. Hindman's cure for what he calls "special conditions" is simply to cease making the parts interchangeable. What will the owners of the original products say to this, when they desire to replace certain parts and find the new ones to be non-interchangeable?

* * *

HORSEPOWER OF NON-METALLIC GEARING

An article entitled "Standardization by Gear Manufacturers," published in November MACHINERY, contains a formula for determining the horsepower transmitting capacity of non-metallic gearing. This formula (page 195) is incorrect, as the pitch line velocity was omitted owing to a typographical error. The correct formula follows:

$$\text{H.P.} = \frac{0.000095 \times S \times FW \times Y \times PLV}{DP}$$

in which H.P. = horsepower; S = safe working stress of material (varies with speed, see values of S in Table 1 of November number, page 194); FW = face width, in inches; Y = a constant depending upon number of teeth (see values of Y in Table 2); PLV = pitch line velocity, in feet per minute; and DP = diametral pitch.

* * *

MACHINE TOOL SALES IN INDIA

In referring to the possibilities for the sales of American machine tools in India, the Department of Commerce mentions that there are only a small number of Indian railways still operated by private companies incorporated in England. These roads still have their purchasing offices in London, but several of the more important Indian railways are now operated by the Indian Government, and for these roads, railway equipment of all kinds, including machine tools for the railroad shops, is purchased through the Indian Stores Department at Delhi upon the recommendation of the Indian Railway Board, located in the same city. "Because of this trend in the operation of Indian railways," says the Department of Commerce in a letter to the National Machine Tool Builders' Association, "and also because of the increasing possibilities of Americans securing important orders as a result of the establishment of the Indian Stores Department in India, it is believed very strongly that much more serious attention should be given to trade opportunities in that country. Several important American manufacturers of railway equipment have recently obtained favorable orders for some of the Indian railways as a result of these recent changes."

To promote sales in India, the best way doubtless is the formation of cooperative export groups among American machine tool builders.

The Machine-building Industry

NEARLY all reports indicate that trade and industry are in a favorable position and that business now rests on a sound foundation. The only basic industries that have not shared in the increasing activity this year have been the textile and leather industries. Leaders in the textile industry, however, describe the outlook as brighter, which promises better general business conditions in New England. There is also a tendency on the part of buyers in all fields to abandon their hand-to-mouth buying policy, and lay in stocks ahead. Their willingness to do so is doubtless due to the difficulty of manufacturers to quote early deliveries on account of increasing demand.

Distribution of goods at wholesale and retail in the Eastern Atlantic states for the last quarter this year will show an increase of from 10 to 15 per cent over the corresponding period of 1924, according to an analysis compiled by the Atlantic States Shippers' Advisory Board. The board's survey was based on forty commodity reports, covering all the basic industries in its territory. This district comprehends New York, New Jersey, eastern Pennsylvania, Maryland, Delaware, eastern Virginia and the District of Columbia. Iron and steel shipments are expected to be 15 to 20 per cent greater during the last quarter of 1925 than a year ago.

The Machine Tool Industry

Leading machine tool builders state that the volume of business is greater than at any time since June, 1920. Many plants are increasing their working forces, and in some centers there is a scarcity of skilled men experienced in the kind of work encountered in machine tool plants. The export trade is more active than it has been for five years, although the rather heavy shipments to Germany early in the year have fallen off considerably. There is more optimism than for some time past, and the prospects for the next six months seem satisfactory to most manufacturers. Most dealers report a satisfactory volume of business. The second-hand machinery competition is no longer a serious problem in most cases, the supply of good used machines not being excessive, but having receded to its normal level.

The small tool industry has been active, but the hand-to-mouth buying policy of customers in this field, and the great number of small orders, many for special tools wanted almost at once, prevent a profitable business, commensurate with the volume of sales. If the manufacturers of small tools are to continue to fill small orders at short notice, the additional cost of doing business that way must necessarily advance prices; and the buying rush that is likely to come with an expected price advance, will make it impossible to supply all comers as promptly as in the past. If the hand-to-mouth buyers find themselves short of tools at that time, the reason is to be found in an economical tendency that has been overdone.

The Iron and Steel Industry

At the present time orders for finished steel, particularly sheets, bars, and tin plates, are exceeding the output of the mills. Prices are firmer and products that in the past could have been delivered within a few days from the placing of the order, are now quoted for six to eight weeks delivery. The mills operate at over 80 per cent capacity, which is from 20 to 25 per cent above the average for the last six years. The malleable casting industry, which has a capacity greater than necessary for any normal demand, is operating between 50 and 60 per cent of capacity, and the steel casting foundries at close to 60 per cent. Pig iron shipments exceed furnace production. The demand for structural building steel continues brisk.

As previously mentioned, the iron and steel industry is now operating at from 20 to 25 per cent above the average for the last six years. This is a significant figure—particularly so when it is noted that the exports this year are about 40 per cent below the average for the last six years. There is also a much smaller volume of steel going into the construction of freight cars this year, so that all considered, domestic consumption of steel in other channels is about 35 per cent above the average for the last six years. Also, steel is not purchased for stock, but for immediate use.

The Automobile Industry

The high record for monthly production in the history of the automobile industry was reached in October, 454,327 passenger cars and trucks being produced in that month. These figures make the total automobile production for the first ten months of this year over 3,620,000 cars. Ford produced 204,000 cars in October, and reached a new record for daily production with 9109 cars on October 31. With unfilled orders running into several hundred thousands, it is expected that the Ford plant will run at high production the rest of the year. *Automotive Industries* has warned against the temptation to over-produce in view of the fact that the preliminary schedules for 1926 apparently call for 5,000,000 cars, against possibly 4,000,000 cars this year. The exports this year will come near to the half million mark. The United States produces 90 per cent of the automobiles in the world.

The Railroad Situation

The railroads are breaking records in carrying freight. All revenue freight continues to run at a high level and to exceed past records for this time of the year. Loadings of revenue freight for the first forty-two weeks of this year have been the greatest for any corresponding period on record.

Somewhat heavier equipment buying is reported. During the first nine months of this year, the railroads placed in service nearly 114,000 freight cars, according to reports filed with the Car Service Division of the American Railway Association. During the same period, 1342 steam locomotives were placed in service. Net earnings show a considerable improvement over last year, and the freight traffic ahead promises to be of a heavy volume. The passenger traffic, on the other hand, shows a decrease, due to the inroad of buses and automobiles. The decrease in passenger traffic is about 7 per cent.

During the last two years there were 434 laws regulating railroads passed by the various state legislatures of the country. Altogether, there were 2274 bills introduced during the same period, so that only 20 per cent of those introduced were enacted into laws. Of the 46 so-called "full-crew" bills introduced, none was passed. The legislatures that had them under consideration seemed to have reached the conclusion that these are matters that belong in the domain of efficient railroad management. Seventeen bills limiting the length of trains were before the legislatures, but here also the law makers seemed to recognize that limiting the efficiency at which railroads might operate and increasing payroll charges would cost somebody a good deal of money unnecessarily, and none of these bills was passed. Nine bills were introduced proposing to prohibit the painting of cars with spray guns instead of by hand brushes, but none of these was enacted into law. Locomotives appear to be a favored subject for legislatures. Fifty-nine bills dealing with them were introduced during the last two years and ten of them were passed.

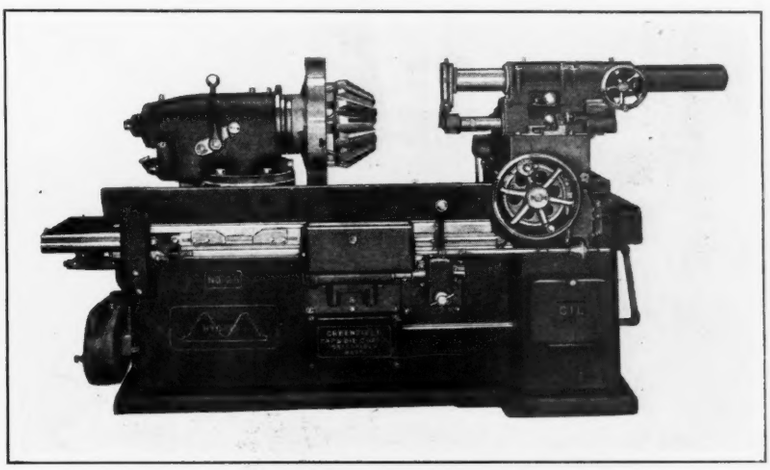
New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

"HYDROIL" HEAVY-DUTY INTERNAL GRINDING MACHINE

Holes up to 16 inches in diameter and 15 inches in depth can be ground on the No. 28 "Hydroil" internal grinding machine recently added to the products of the Greenfield Tap & Die Corporation, Greenfield, Mass. The machine is particularly adapted to big-bore grinding, and can be furnished in two sizes the smaller of which has a 28-inch swing and the larger, a 36-inch swing. Taper work can be ground, and there is provision for grinding the face of the work at the same setting as the hole. The illustration shows a front view of the machine, from which it will be noted that it is built low to insure rigidity and provide for the easy handling of heavy work.

The wheel-head slide has no longitudinal movement—simply a cross movement on a bridge that is provided with one flat way and one vee. Accurate alignment is claimed for this design and the transmission of power to the wheel-spindle with entire freedom from vibration. From one position the operator has complete control of the machine. Wheel-spindles of different sizes are furnished to suit the work in question. The machine is entirely self-contained, so that it may be driven by a single belt from a lineshaft or by a silent chain and sprockets from a motor attached to the base. One motor drives the entire machine.



Greenfield "Hydroil" Internal Grinding Machine of Large Capacity

The work-table is reciprocated hydraulically by oil under pressure, the speed being regulated by means of a valve located at the front of the machine within easy reach of the operator. The work-spindle is designed to carry heavy loads, and has a threaded nose 8 inches in diameter. A threaded ring is regularly furnished to screw on this nose, for the attachment of faceplates, chucks, or fixtures. The feed-screw is equipped with ball thrust bearings and runs in a bath of oil. The handwheel for operating this screw is 14 inches in diameter and works in connection with a positive stop.

The wheel-truing device is mounted on top of the wheel-head housing and operated through a handwheel. The truing element, either a diamond or another dressing tool, is held at the end of a ram. The construction is such as to make the wheel truing almost instantaneous. Adjustment is provided for the truing element to compensate for wear of the wheel or for using various diameters of wheels.

The machine is so designed that all parts are readily accessible for adjustment or repairs. Water guards prevent grit from working into the various bearings and slides, and protect the operator against the spray of lubricant while the machine is in operation. When the machine is arranged for a 28-inch swing, the center of the work-spindle is 44 inches above the floor, and when arranged for a 36-inch swing, this dimension is 48 inches. The floor space required is about 11 1/2 by 5 1/2 feet, and the weight of the machine is approximately 8800 pounds.

SOCIETE GENEVOISE LOCATING AND JIG BORING MACHINE

Another precision locating and jig boring machine of considerably larger capacity than previous models built by the company, has recently been developed by the Societe Genevoise d'Instruments de Physique, Geneva, Switzerland, and is being introduced in the United States by the R. Y. Ferner Co., Investment Bldg., Washington, D. C. This machine—the No. 6—is similar in construction to the Nos. 4 and 5 machines, having a horizontal bed with ways along which the work-table is moved by means of an accurate lead-screw, and two uprights which carry a cross-slide on which the tool-holder is mounted. The tool-holder is actuated by a second precision lead-screw. The accuracy of this new machine is said to correspond closely to that of the Nos. 4 and 5 machines, for which the maximum error in the distance between the axes of bored holes for the full capacity of the machine, is 0.0006 and 0.0008 inch, respectively.

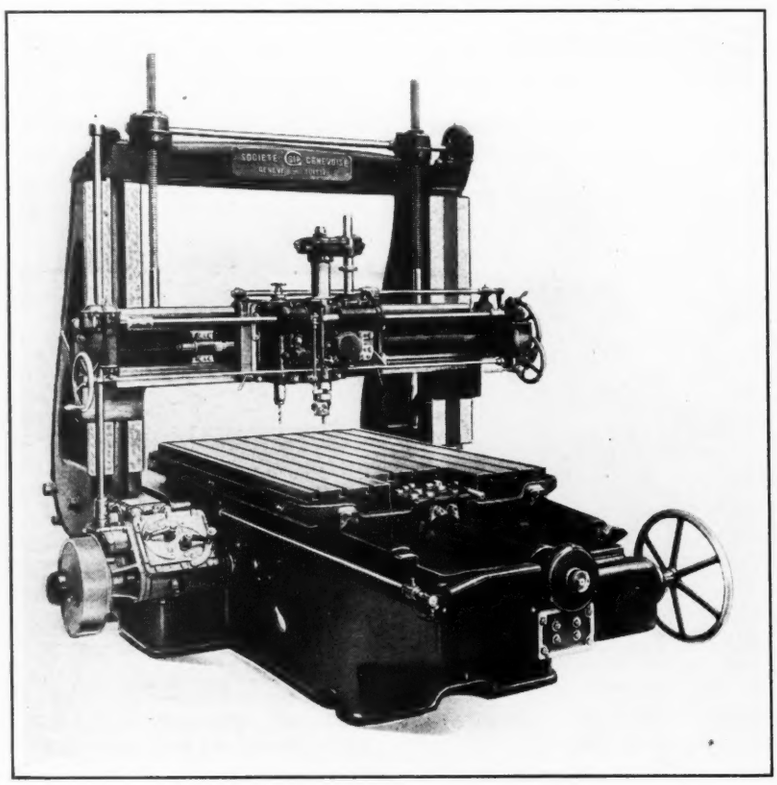
The two lead-screws have a pitch of five threads per inch, and are equipped with micrometer heads graduated to 0.0005 inch, on which there are verniers for taking readings to 0.00005 inch. The micrometer heads are protected from injury by shields in which an opening is provided for taking the reading. Any errors of both lead-screws are automatically compensated for by means of curved templets which have been cut in accordance with the measured errors of the lead-screws when mounted in place. A steel finger follows the contour of the templet as the table or tool-holder moves along, and through a lever system automatically shifts the vernier index and the micrometer head back and forth slightly to make corrections for small errors in the screw.

Owing to the length of travel of the work-table and the weight of the table, provision is made for feeding the table by power over the major part of its movement between two points. This drive is controlled by a lever, the table stopping automatically when the lever is not held out of its former position by the operator. A 2 1/2-horsepower constant-speed motor is used for driving the machine. The drive from this motor is through a belt to the pulley of a nine-speed gear reduction box mounted on the left-hand side of the machine.

Two drilling and boring spindles are mounted on the tool carriage. The larger one, which is intended for the main drilling and boring operations, has a No. 3 Morse taper socket and is capable of drilling holes from 3/4 to 1 3/4

inches in diameter or boring holes up to 6 inches. The smaller spindle operates at high speeds, has a No. 2 Morse taper socket, and is capable of drilling holes from 3/16 to 3/4 inch in diameter. The vertical movement of the large spindle is 10 inches, and of the small, 4 inches. Automatic feed of both spindles may be obtained at the rate of 0.003, 0.005, 0.008, and 0.012 inch per revolution, while nine spindle speeds ranging from 40 to 200 revolutions per minute are obtainable for the large spindle and a similar number of speeds ranging from 200 to 1000 revolutions per minute, for the high-speed spindle. The axes of the two spindles are fixed distances apart, so that in making settings of one spindle relative to holes laid out by means of the other, it is simply necessary to add or subtract an integral number of inches to or from the reading of the zero reference point. Both spindles are controlled through a clutch coupling that can be operated from either side of the machine.

Not only is it possible with this machine to lay out work in rectangular coordinates, starting with one hole as a reference point, from a machined edge of the work or from some other zero point, but provision is also made for laying out points in polar coordinates. For this purpose a 24-inch circular dividing table is furnished for attachment to the work-table. The center of the circular table may be set centrally beneath the axis of either spindle, by mounting centers in the spindle and the circular table and placing a rotatable level between them. The settings of the circular table are measured by means of a micrometer head equipped with a vernier index that gives readings to one second of an arc, although the accuracy of these settings can only be from 15 to 20 seconds of an arc, owing to the necessarily short bearing of the circular table spindle.



Societe Genevoise Locating and Jig Boring Machine

The machine is also equipped with an adjustable indicating device that is mounted in the spindle of the machine for use in lining up or centering work on the table. A microscope with a "broken" tube, similar to that furnished on previous machines, can be mounted in the spindle for checking purposes or for measuring up an old job to determine its present accuracy. Also, a semi-automatic center-punch such as used on previous machines, may be mounted in the spindle. By rotating a knurled ring on this punching device, the point is raised by cam action, until the compression of a spring is sufficient to produce the depth of mark desired, upon which the punch is suddenly released to make the mark. Holes to be drilled and bored can be rapidly laid out with this device, and then the drill can be inserted for drilling them. Finally, a boring tool or end-mill may be inserted in the spindle for a finishing cut, without the necessity of making any check measurements during the process.

In addition to using this machine for producing holes in jigs and fixtures, it may be employed for laying out and cutting profiling dies, punches, cams, and gages. Some of the principal dimensions are as follows: Size of work-table, 40 by 59 inches; longitudinal travel of table, 51 inches; transverse travel of tool-slide, 40 inches; vertical travel of cross-rail, 30 inches; maximum distance of tool above table, 33 1/2 inches; total width of machine, 100 inches; and total length of space required for machine when the table is in its extreme position, 12 feet 2 inches. The approximate weight of the machine is 10,000 pounds.

OAKMONT INTERNAL GRINDER

The principal claim made for the internal grinding machine shown in the accompanying illustrations, is that the wheel carriage will positively reverse within 0.0005 inch of any predetermined point. This means that it is possible to grind close to shoulders and to the bottom of blind holes without providing a recess at the shoulder or at the bottom of the hole. This machine is a recent product of the Oakmont Mfg. Co., Oakmont, Upper Darby Post Office, Philadelphia, Pa. The accuracy obtained in reversals is said to be due to the elimination of shocks by not changing the direction of rotation of any part in the traverse mechanism. The carriage is stopped at a point directly ahead of its center of gravity, and it is driven at its center of gravity. This is said to obviate all tendency for the carriage to be thrown out of alignment.

The drive to the carriage is from a variable-speed motor, and is engaged and disengaged by means of a clutch operated by lever *A*. When the power traverse is disengaged, a hand traverse through wheel *B* is engaged, and vice versa. Changes in the traverse speed are obtained by operating the rheostat handle *C*. In the event that a piece of work, a wrench, or any other foreign object becomes lodged between a fixed part of the machine and the moving carriage, the carriage will automatically reverse and move away from the object without damaging the machine or throwing any parts out of adjustment. Upon the removal of the interference, the carriage will again be returned to its positive stop.

The wheel-head is mounted on the upper of two cross-slides, the upper slide taking the cross-feed and having only a short movement, which prevents the use of too small a wheel on a job and thus eliminates a time wasting practice. The lower slide is provided to allow a quick backward motion when setting the machine for taper or step work. The wheel motor is suspended from the carriage, and drives through a belt that is self-adjusting for stretch. There is a constant-tension device that may be adjusted as required.

The wheel feed may be operated either by means of the handwheel *D* or automatically at each end of the carriage travel. An automatic feed straight in to the work is also available when there is no carriage travel. Graduations on

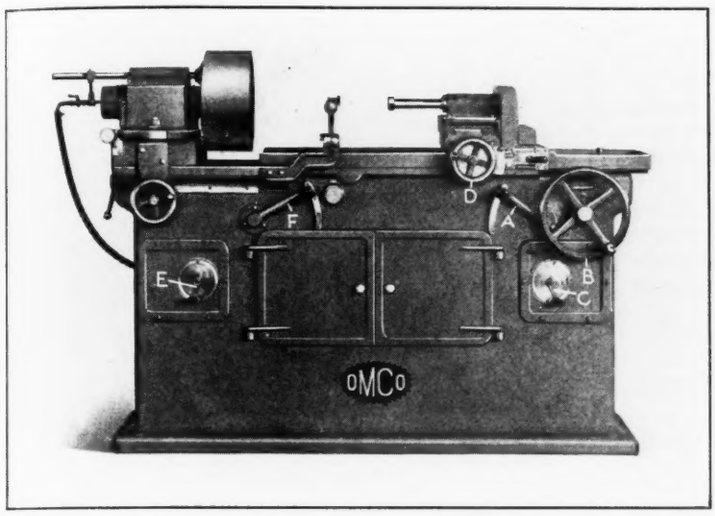


Fig. 1. Oakmont Internal Grinding Machine

the feed dial for adjustments of 0.001 inch in the diameter of the work are approximately 3/4 inch apart, and these, in turn, are subdivided into five parts, so that there is a subdivision for each 0.0002 inch of the work diameter. The automatic feed can be varied in increments of 0.0002 inch from the maximum to zero by moving down the graduated sector located immediately to the right of the hand-feed wheel.

The work-head is also driven by a variable-speed motor, the speed changes of which are obtained through the rheostat handle *E*. The driving belt is self-adjusting for stretch, and is provided with a constant-tension device, adjustable to any desired degree. Starting and stopping of the work-head spindle is quickly accomplished through lever *F*, without using a friction clutch. The spindle is of the double taper type with an easy and positive adjustment for wear, and has a large hole for the collet tube and water pipe. The work-head may be swiveled and is graduated to 15 degrees.

The pump and tank are integral and mounted on the back of the bed in such a way as not to occupy more floor space than is required for full operation of the machine. The pump is of the paddle type and is driven from the same source as the work-head, which insures stopping and starting the water simultaneously with the work. All units within the machine are mounted on conveniently hinged plates to make them readily accessible for inspection and repairs. Some of the specifications are as follows: Maximum diameter of hole that can be ground, 12 inches; maximum depth of hole that can be ground, 10 inches; diameter of hole in spindle, 1 5/8 inches; number of work-head spindle speeds, twenty-six, ranging from 20 to 180 revolutions per minute; number of traverse speeds, thirteen, from 20 to 60 inches per minute; full operating floor space, 78 by 29 inches; and weight of machine, 2400 pounds.

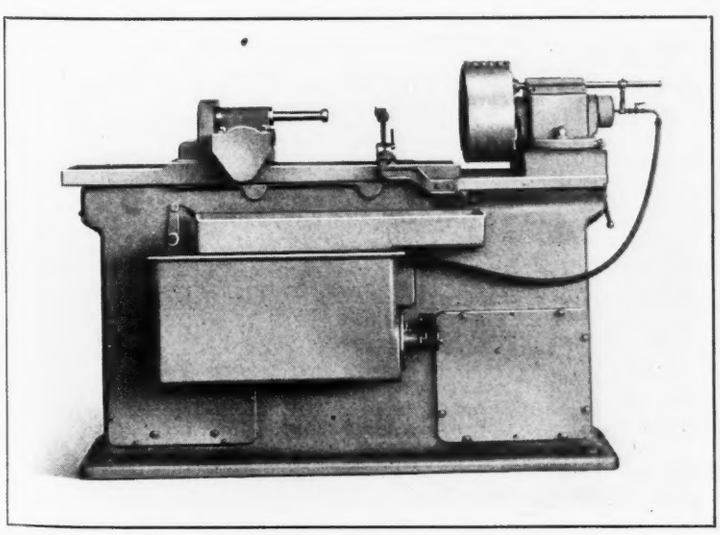
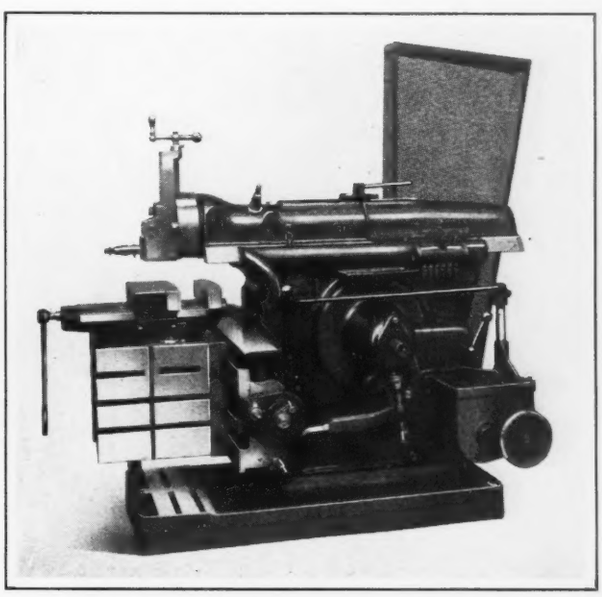


Fig. 2. Rear View of Grinding Machine showing Water Tank

GOULD & EBERHARDT SHAPER

There has recently been placed on the market by Gould & Eberhardt, Newark, N. J., a 24-inch "Invincible" shaper which supersedes the 24-inch "High Duty" shaper of this company's manufacture. The new machine is designed for hard or tough work, which does not require a long stroke for finishing it, but does necessitate a machine capable of taking heavy cuts without chattering or breaking down under the strain. On jobs requiring light cuts at high speeds, the machine can be operated as fast as most smaller sizes.

The new machine has the same frame, ram, gearing, speed gear-box, tool-head, and vise as the 32-inch shaper described in July, 1924, MACHINERY. However, the



Gould & Eberhardt 24-Inch "Invincible" Shaper

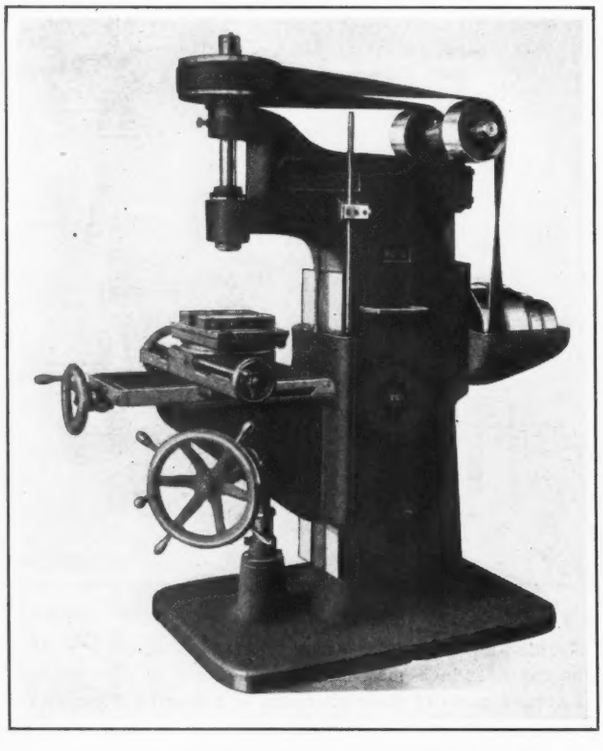
cross-rail and table have been reduced to suitable proportions for a 24-inch machine, and the base is also shorter. The arrangement of the rocker arm and gearing is such that the total height from the floor to the top of the tool-head handle on both the 24- and 32-inch sizes is only 1 1/2 inches more than on the 16-inch machine. This makes it convenient for the operator to reach every operating lever on the machine.

In addition to the features mentioned in the July, 1924, article, there are several new points. For instance, there is a new type of twin disk clutch which engages and disengages with ease, while a brake gives the operator instant control. The bull gear has been raised until it almost touches the ram, which is said to increase the power arm and lessen the strains on the main lever. The handwheel on the speed gear-box is connected to the main drive shaft and affords a means of accurately adjusting the ram to bring the tool up to a line. A 3-inch hole extends the entire length of the frame on one side of the center, to permit keyseating shafts with the tool-head set at a slight angle. The 24-inch machine weighs about 5600 pounds.

PRATT & WHITNEY IMPROVED DIE-SINKERS

Improved designs of the Nos. 2 and 3 die-sinkers built by the Pratt & Whitney Co., Hartford, Conn., have recently been brought out. The new models are heavier and more rigid than the previous machines, and have a correspondingly greater ability to stand up under severe service. The increase in weight is about 30 per cent, and is mainly in the column. Another improvement is that the wearing surfaces of the knee slides and of the table slides have been broadened so as to reduce wear to a minimum and increase the accuracy of the machine.

The drive has been changed in that the cone pulley has been moved to a higher position in back of the column. This construction makes the machine easily adaptable to either a belt or motor drive. The idler pulleys for the spindle drive belt have been made adjustable so that the tension of the belt can be regulated. Also, these pulleys have been equipped with oilless bearings. To obtain ease of operation, the knee has been counterweighted and the elevating screw equipped with ball thrust washers. Other improvements consist of a wider range of spindle speeds, and a new spindle-pulley lock that enables the cutters to be easily removed.

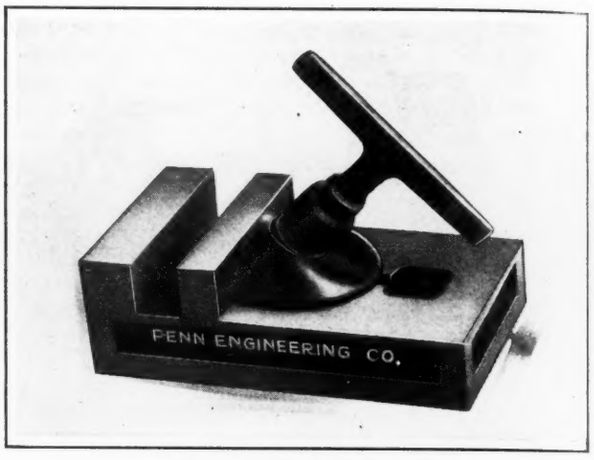


Pratt & Whitney Die-sinking Machine of Improved Design

Except for the improvements mentioned, the new machines are similar to the previous models. The large handwheels are in approximately the same locations, and the feed-screws are equipped with micrometer rings that permit the necessary accuracy in controlling the movement of the work. An adjustable stop insures the proper depth of cut. Graduations and zero marks on all slides provide a rapid means of setting and centering work under the cutter. The rotary vise feed is valuable in taking a circular cut. Lapped thrust washers are furnished for the spindle and large taper bronze boxes that insure accurate alignment.

PENN QUICK-ADJUSTING VISE

A quick-adjusting vise intended for general application on machines has recently been introduced to the trade by the Penn Engineering Co., 511 N. 3rd St., Reading, Pa. The quick adjustment is accomplished by means of a sliding hook-bolt which may be moved quickly through a slot running lengthwise in the base, to shift the movable jaw back and forth. In gripping work in the vise, the nut handle on this bolt is rotated to draw a hook at the lower end of the bolt against lugs cast equidistantly along the inside of the base top. In tightening the bolt, the movable jaw is pushed toward the fixed jaw, and at the same time is drawn toward the base in such a way that the work is pulled down with it. The movable jaw is of a swivel design which enables tapered and odd-shaped pieces to be held. The vise is made in three sizes having 3 1/2-, 5 1/2-, and 8-inch jaws, and weighing 16, 31, and 56 pounds, respectively.

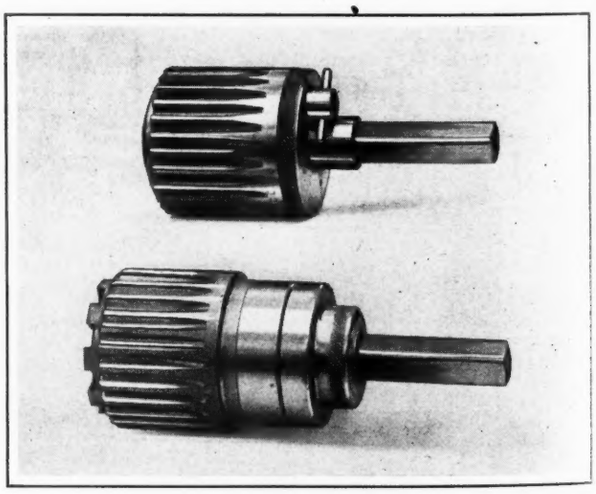


Penn Quick-adjusting Vise

CINCINNATI "HYPRO" SAFETY TRIGGER GEAR

Safety was the factor in mind in designing the new safety trigger gear now provided on the "Hypro" planers built by the Cincinnati Planer Co., Cincinnati, Ohio. On the old style of trigger gear, which is shown at the top of the accompanying illustration, a pawl handle, used to change the direction of the feed, had a pin through the head. When the operator changed the direction of the feed while the feed was taking place, the chances were that he would have his fingers caught between the pin and the shaft.

On the safety style of trigger gear shown at the bottom of the illustration, there are no projections to catch the fingers of the operator; in place of the handle and pin, a round knurled knob is provided. With this style, when the operator is making a change in the feeding direction, the knurled knob will turn in his hand without causing any injury. It is also possible to change the direction of the feed at any time.



Old and New Styles of Trigger Gears furnished on Cincinnati Planers

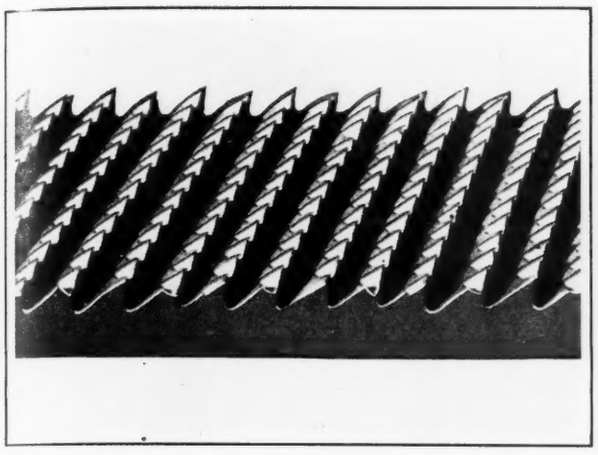


Illustration showing the Design of the Teeth on a "Shearkleen" File

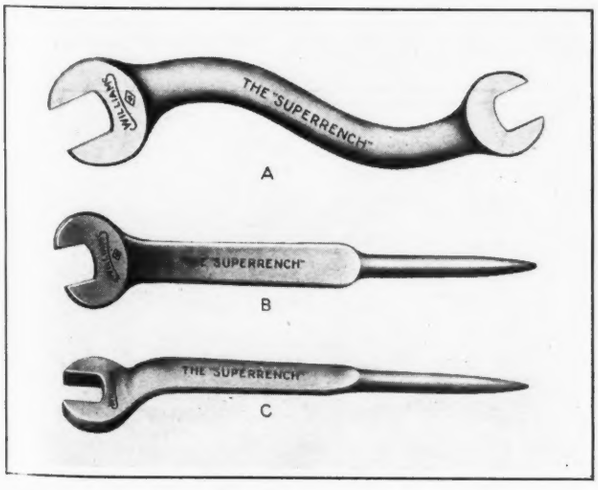
"SHEARKLEEN" DOUBLE-CUT FILES

The feature of a line of "Shearkleen" double-cut files recently placed on the market by the Service Tool Corporation, Latrobe, Pa., is that all the teeth are made with a positive rake or under-cut on the front and a double slope on the back. They are milled to shape from solid stock, so that the cutting edges are sharp and clean. Each tooth is properly spaced to avoid "tracking," and deep enough to prevent clogging. The teeth are self-cleaning on all hard or soft metals, and are very satisfactory for use on wood or leather.

The deep spaces between the teeth and the shape of the teeth make it possible to restore these files to their original sharpness by the sand-blast process, and it is said that this operation can be repeated many times before the teeth are worn too short for effective use. The files are made from a special alloy steel in standard sizes.

WILLIAMS CHROME-MOLYBDENUM STEEL WRENCHES

A line of wrenches made from chrome-molybdenum steel has just been introduced on the market by J. H. Williams & Co., Buffalo, N. Y., to supplement their carbon-steel drop-forged wrenches. These new products are known by the trade name of "Superrench," and are made from chrome-molybdenum steel because it makes possible a refinement in design and a decrease in weight that are said to be impossible of attainment with carbon steel. It permits thinner sections and narrow pointed jaws that give efficient service in cramped quarters. It is claimed that one of these wrenches will strip the thread of any standard nut or break the bolt without spreading the jaws.



Three Styles of Chrome-molybdenum Steel Wrenches made by J. H. Williams & Co.

The new wrenches are available in four styles, all of which are heat-treated. These styles include an engineers' pattern double-head wrench having 15-degree angle openings. This wrench has thin, narrow jaws and is of generous length. The second style, shown at *A*, is a general-service S-pattern of light design, with an unusual leverage. Both of these styles are furnished with a nickel finish and with the heads buffed bright. The third style, shown at *B*, is a construction pattern with a single head having a 15-degree angle opening, while the last style, illustrated at *C*, is a structural pattern with a single-head, straight opening, and an offset handle. The last two styles are treated to prevent corrosion in outdoor service and have a silvery gray finish.

CAULKINS FULL AUTOMATIC DRILLING MACHINE

A Caulkins special "super-sensitive" drilling machine recently placed on the market by E. L. Krag & Co., 542 W. Jackson Blvd., Chicago, Ill., is shown in the accompanying illustration. This machine is designed primarily for drilling 1/8-inch cotter-pin holes in 3/8-inch bolts, but it can readily

Caulkins Automatic Machine designed for drilling Cotter-pin Holes in Bolts

be adapted to other kinds of sensitive drilling when quantity warrants a special machine. The designers of the machine adopted a slower spindle speed than is customarily used, which they believe to give the highest production when all factors are considered. High spindle speeds do not always result in the highest production, since the tools may need frequent grinding or may break often. The speed is about 25 per cent below the usual practice.

The spindles have a travel of only slightly more than the diameter of the stock, and are fed at the rate of about 0.004 inch per revolution. Power for the feed is derived from a friction clutch, which, when the tension is properly adjusted, drives a sharp drill through average stock without slipping, but permits slipping if the drill becomes dull or strikes an unusually hard piece of stock. This almost entirely eliminates the breakage of drills and the consequent loss of time in changing them.

The operator has little to do, and is said to be able to tend as many as twenty of these machines. His work consists mainly of changing drills, which is done about twice daily. A gage used in setting the drills enables the operator to replace them in a few seconds. There are only six revolutions of the spindle from the time that one bolt is drilled until the drill starts against another bolt.

The machine may be built for drilling one hole in bolts up to 1/2 inch in diameter; for drilling six holes in the heads of bolts, in which case the machine indexes and drills automatically; for drilling one or two holes in studs, pins, tubing, etc.; and for burring washers. Countersinking can also be done. The machine illustrated drills the bolts at the rate of 2160 per hour or 17,280 per day of eight hours. It weighs about 750 pounds.

PEERLESS METAL-SAWING MACHINES

A 9- by 9-inch "Universal" high-speed metal-sawing machine is now manufactured by the Peerless Machine Co., Racine, Wis. As in the case of the 6- by 6-inch and 13- by 13-inch sizes, the new machine is provided with a "full-square" saw-blade frame; quickly adjustable spring-controlled feed pressure, with a worm and ratchet type of feed;

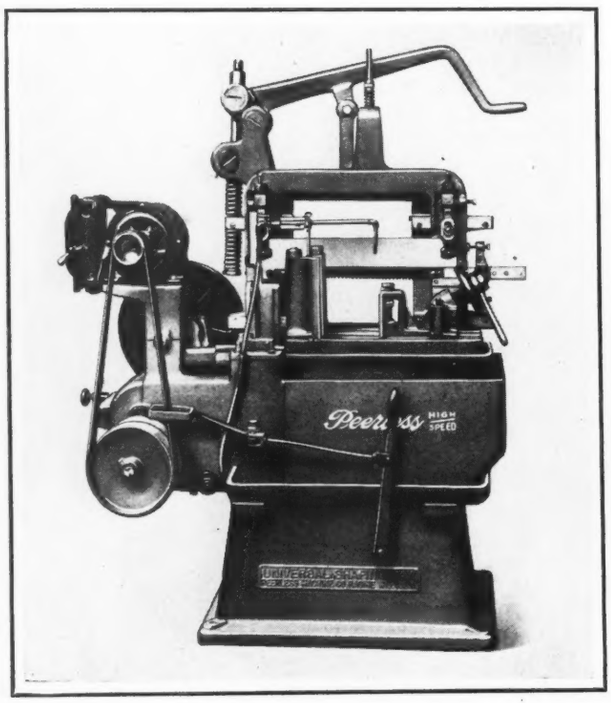


Fig. 1. Peerless High-speed Metal-sawing Machine

blade backing plate; swivel vise; three-speed gear-box; lift on the non-cutting stroke; automatic stop and lift of the frame to the starting position upon the completion of a cut; and height and depth gages.

Important specifications of the machine are as follows: Capacity at an angle of 45 degrees, 6 inches; length of blade, from 14 to 17 inches; number of strokes, three, of 125, 85, and 50 per minute; length of stroke, 6 inches; power required, 1 1/2 horsepower; and weight of saw without motor, 1400 pounds.

Another recent product of the same company is the "Dry Cut" power metal-sawing machine illustrated in Fig. 2, which has a capacity of 4 1/2 by 4 1/2 inches. This machine is intended for maintenance and general-purpose work when a larger machine is not needed. To as great an extent as possible, the same principles of construction and operation incorporated in other Peerless machines, have been embodied in this machine. It is provided with a lift on the non-cutting stroke, a quickly adjustable spring-controlled feed pressure, and an automatic stop at the completion of

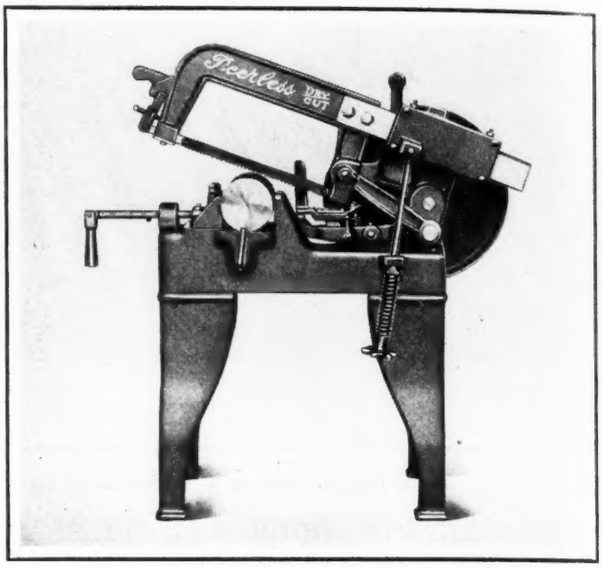


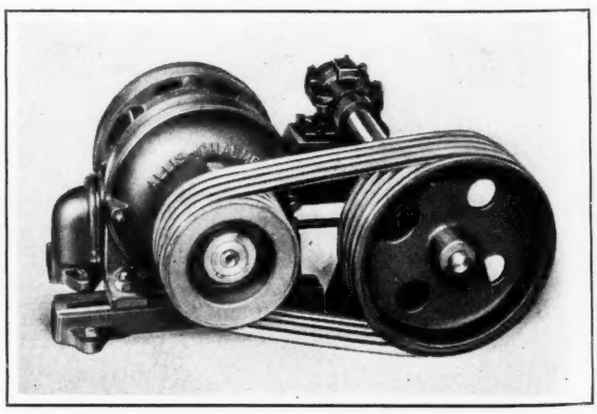
Fig. 2. Peerless "Dry Cut" Sawing Machine

the cut. While setting stock, etc., the saw frame will remain in any position in which it is placed.

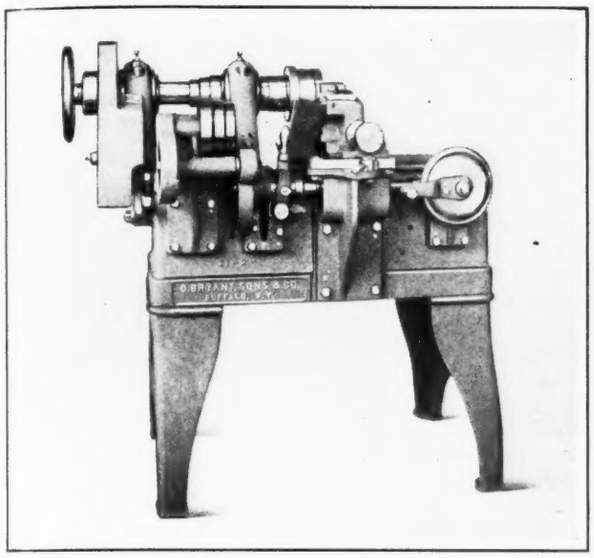
Being a dry-cutting machine, it runs at a comparatively low speed, but it is possible to run it at 100 strokes per minute when cutting low-carbon stock. It is said that it cuts this material almost as fast as high-speed machines. This machine takes a blade 10 inches long and has a stroke of 4 1/2 inches. One-quarter horsepower is required for driving it, and the net weight is 165 pounds.

ALLIS-CHALMERS "TEXROPE" DRIVE

A development in power-transmission machinery that has just been announced to the trade by the Allis-Chalmers Mfg. Co., Milwaukee, Wis., consists of a new type of short-center flexible drive known as the "Texrope." In this drive there are two grooved sheaves and a number of specially constructed endless V-belts, as shown in the accompanying illustration. The sheaves are set just far enough apart so that the belts fit the grooves without either tension or slack, and hence there is said to be no lost motion in the drive. Because of the V-construction, the belts cannot slip; the harder the pull, the more firmly the belts grip the grooves. Being elastic, the belts cannot jerk either in starting or running, nor can they transmit vibrations, but act as "cushions" between the driving and driven mechanisms. Bearing pressures are low, since there is no belt tension. "Texrope" drives from 1/2 to 250 horsepower, with ratios up to 7 to 1, and belt speeds from 800 to 6000 feet per minute, have already been installed for driving machine tools, conveyors, elevators, and many other kinds of machinery.



"Texrope" Short-center Flexible Drive



Bryant Turning Machine for Nipples and Similar Parts up to 9 Inches in Diameter

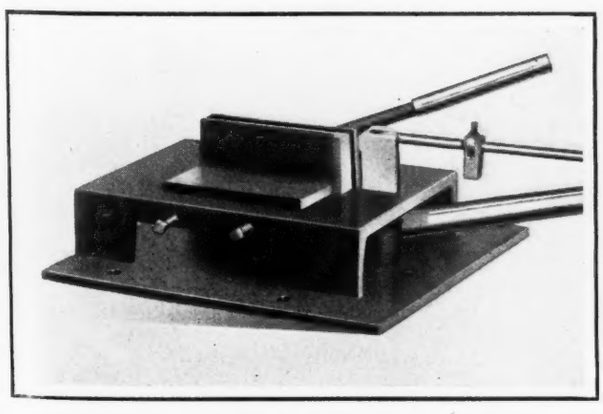
BRYANT NIPPLE TURNING MACHINE

Boiler nipples and similar work from 2 to 9 inches in diameter and from 1/2 to 6 inches in length, can be turned as required in a machine built by O. Bryant Sons & Co., 366 Ontario St., Buffalo, N. Y. The work must be hollow, since it is held on an arbor that is inserted in one end and expanded against the wall of the work. Expansion of the arbor is accomplished by revolving the handwheel on the headstock end of the machine.

Turning of the work to any desired form, such as to a taper, to a double taper, concave or convex, is accomplished by means of a form that is placed in front of the tool carriage for controlling the transverse movements of the tool-slide as the carriage is fed longitudinally. The carriage is fed by power during the operation. When a piece has been completed, the carriage is withdrawn to the right-hand end of the bed by revolving the crank on the large bevel gear.

"BUCKEYE" BENDER

A bending tool known as the "Buckeye" bender has recently been placed on the market by the Dreis & Krump Mfg. Co., 74th St. and Loomis Boulevard, Chicago, Ill., for bending steel bars and angle-irons. All parts of the device are made of steel, and the working parts are hardened. The base is a steel plate, and the body is formed of an inverted channel iron arc-welded to the baseplate. In bending a piece, the material is held in place by means of an eccentric, which is said to insure accurate work. Adjustments are easily made to suit different thicknesses of stock. The bending leaf is a hardened steel piece which bears on both the baseplate and the channel-iron. An adjustable drop gage is furnished for use in making short bends. Notched angle-irons can be bent up to 90 degrees. The device has a capacity for mild steel bars 1/4 by 2 inches in cross-section. The steel plate which comprises the base is 12 inches square.

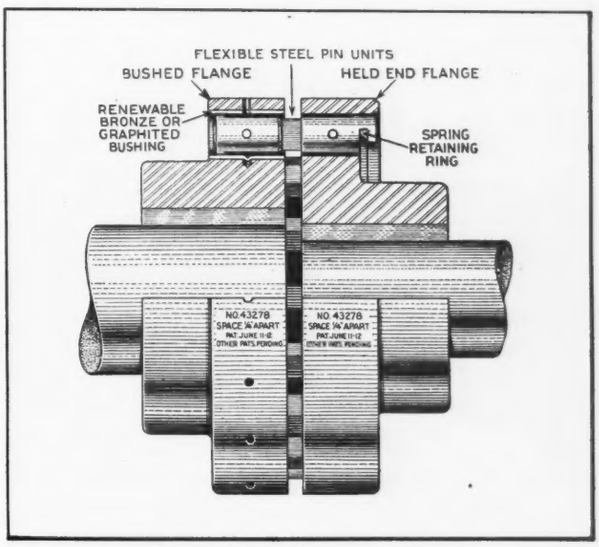


"Buckeye" Bending Tool for Steel Bars and Angle-irons

FRANCKE FLEXIBLE COUPLINGS

An improved line of bushed-pin flexible couplings intended for motor, turbine, and engine drives is being introduced to the trade by Smith & Serrell, 62 Washington St., Newark, N. J. There will be twenty-one regular sizes between the smallest, which has a rating of 2/3 horsepower per 100 revolutions per minute, and which may be run up to 4000 revolutions per minute, and the largest, which has a rating of 3850 horsepower per 100 revolutions per minute and which may run up to 490 revolutions per minute. The couplings are intended for mounting on shafts from 3/4 to 13 inches in diameter.

Some features of the old heavy-pattern couplings made by this company are retained in the improved design, and several new ones have been introduced, which permit greater and easier endwise movement, give more power, and last longer. The graphited-bronze bushings are locked in one flange of the larger couplings, and the plain bronze bushings in the smaller sizes, the bushings in both cases being removable. The steel pin units are free to slide a full 1/2 inch within these bushings. The graphited bushings retain their lubricating qualities for many years.

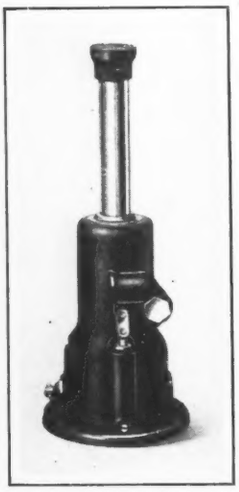

FLEXIBLE STEEL PIN UNITS
BUSHED FLANGE
HELD END FLANGE
RENEWABLE BRONZE OR GRAPHITED BUSHING
SPRING RETAINING RING
NO 4327B SPACE ¼" APART PAT. JUNE 11-12 OTHER PATS. PENDING
NO 4327B SPACE ¼" APART PAT. JUNE 11-12 OTHER PATS. PENDING

Francke Improved Bushed-pin Flexible Coupling

The couplings compensate for all accidental misalignment of the shafts in both an angular and an endwise direction. They "cushion" starting and load shocks, absorb vibration, and run in either direction. In the case of excessive misalignment, a coupling will act as a safety device preventing broken or scored shafts, bearing troubles, etc. However, if more than the usual misalignment is expected, due to non-rigid foundations or other reasons, two couplings in tandem with an intermediate shaft or a Francke double-floating ring coupling are recommended by the manufacturer.

PEDERSEN "OILJAK"

One of the important features of the Pedersen "Oiljak" which is being placed on the market by the Oil Jack Co., Inc., 1457 Broadway, New York City, is that the load positively retains its position at any point of the stroke the instant the user stops pumping. In raising the jack, a handle inserted in the socket is lifted to raise a pump plunger



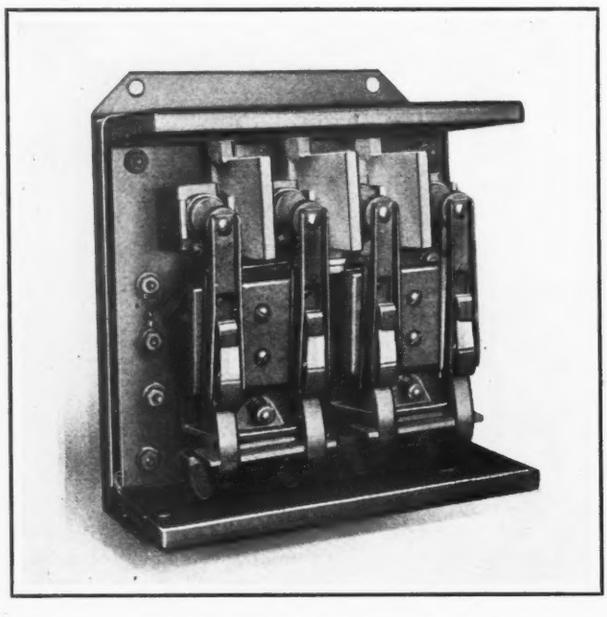
Pedersen "Oiljak"

which draws oil from a reservoir into a chamber. Lowering the handle compresses the oil in the chamber, seats a valve, and forces the oil into a second chamber, causing a plunger to rise and lift the load. In lowering the jack, a needle valve is opened slightly to permit the oil to return to the reservoir.

Oil in the reservoir, which is in the main casting, is not under pressure, and the chamber in which pressure occurs is surrounded by a steel jacket, so that there is no chance of leakage, expansion, or breakage. It is mentioned that loads are lowered without jar or shock and that they can be instantly stopped in any position. The jack may be operated with short "inch-by-inch" motions of the handle, if desired, which is often desirable in cramped quarters. In dangerous locations the jack can be operated at a distance by using a long handle. This jack is now made in a 10-ton size, but 1-, 3-, and 6-ton sizes are to be added to the line.

MONITOR HOIST CONTROLLER

A control outfit consisting of a reversing controller equipped with a rope-operated control master station has recently been brought out by the Monitor Controller Co., Baltimore, Md. This outfit is intended for use on traveling



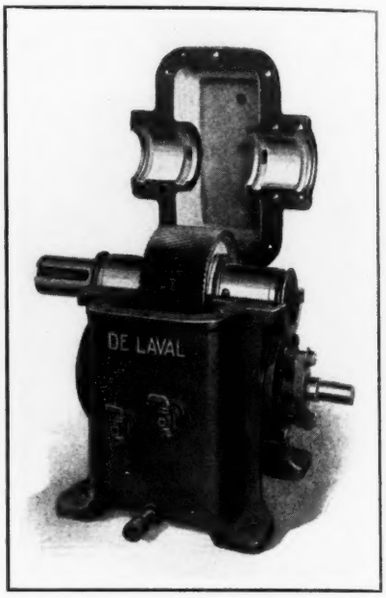
Monitor Controller for Hoists, Cranes, etc.

cranes, chain and rope hoists, or similar equipment requiring a compact outfit possessing safety features. The controller is of a standardized design, and may be used with direct-current or polyphase alternating-current motors that are thrown across the line for starting.

The controller is provided with two double-pole mechanically interlocked contactors having graphite-to-copper contacts, blow-out magnets, and suitable barriers, all mounted on an 8- by 7-inch panel. The over-all dimensions of the controller are 8 1/2 by 10 1/2 by 6 inches. The control master is of the fully enclosed self-centering type. It is always in the "off" position except when held forcibly by the operator in either the forward or the reverse position. The station is only 3 1/2 inches high by 3 inches deep. Bosses cast on the housing protect the contacts from damage.

DE LAVAL HELICAL SPEED REDUCER

The line of worm-gear speed reducers built by the De Laval Steam Turbine Co., Trenton, N. J., has recently been supplemented by a helical-gear speed reducer which is intended for applications requiring ratios between 2 to 1 and 5 to 1. This reducer is used principally to increase and decrease speeds in connection with electric motors and gas engines. The helical gear has the advantages of uniform transmission of motion, absence of vibration, and noiseless operation. Large helical gears transmitting high power are generally made with a double helix of opposing angles in order to eliminate end thrust. However, with small helical gears transmitting moderate power, such as the one illustrated, the double helix is not necessary, as the thrust generated is easily taken care of by a thrust bearing. A one-piece casing insures alignment of the gear and pinion and the maintenance of proper center distances. It also serves as a reservoir and container for the oil.



De Laval Helical Speed-reducing Gear

The gear shaft is fitted with an oil slinger and oil guards, and the pinion is supplied with a split gland that can be removed without disturbing the coupling or any portion of the reduction. This gear reducer is usually supplied with a flexible coupling to avoid any strains from expansion or from a slight movement between the driver and the driven machine. The casing design permits the free circulation of cooling air beneath and around the casing.

TRENT ELECTRIC MELTING POTS

Two electric melting pots, for melting babbitt, solder, lead, tin, etc., are being placed on the market by Harold E. Trent, 259-261 N. Lawrence St., Philadelphia, Pa. The pot

Fig. 1. Trent Melting Pot

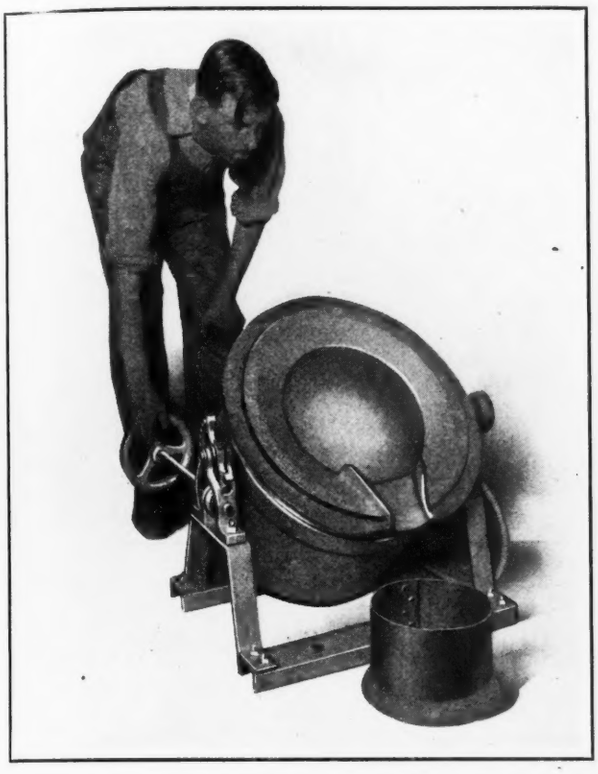


Fig. 2. Trent Melting Pot of 180 Pounds Capacity

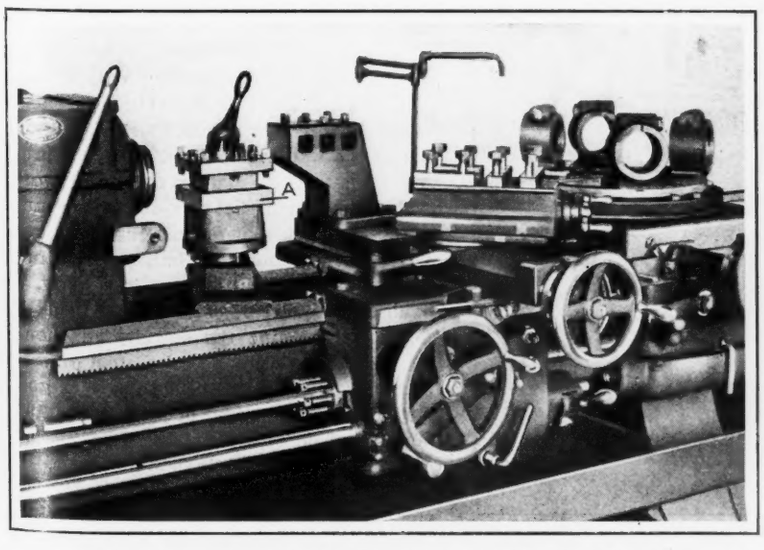
shown in Fig. 2 is provided with a 12-inch crucible, and has a capacity for 180 pounds of lead. It can be mounted on a tilting mechanism as illustrated, or can be fitted stationary in a bench or seated on the floor. Temperature controls can be provided to special order. The over-all height of the pot is 14 inches.

The pot illustrated in Fig. 1 is intended for use in melting small quantities of the metals mentioned. It has a capacity for 10 pounds of lead, and heats in about twenty-five minutes. A single- or three-heat switch can be furnished. The casing is made of sheet metal, and the handle is so arranged that it is never too hot to permit carrying the pot. Spouts and additional handles are supplied when the pot is to be used for pouring. The outside diameter of this pot is 7 1/4 inches, and the height, 7 inches.

ACME BEVEL-GEAR TURNING MACHINE

Bevel gears and similar parts can be finished on their angular surfaces in a machine recently developed by the Acme Machine Tool Co., Cincinnati, Ohio. This machine is the standard No. 2 universal flat turret lathe built by the same concern, equipped with a special carriage and a power feed to the compound rest. Power taken from the cross-feed by gears can be selectively delivered to either the cross-slide screw or the compound-rest screw for driving these screws in either direction. The angle of the cut can be adjusted to meet requirements.

In turning a bevel gear, the carriage is locked to the bed and the cross-slide to the carriage, but the compound rest is fed in whatever direction it is set. By observation and fixed stops, it is an easy matter always to return the compound rest to the starting position for a new piece. The cross-slide is of unusual length, and at the rear end there is a block in which tools may be mounted for taking straight turning or facing cuts on the work. The compound rest has a travel of 5 inches, and the cross-slide a transverse movement of 6 3/4 inches, while the swing over the cross-slide is 12 inches. The compound rest can be easily removed and replaced by the four-way toolpost *A*, which is similar to the one regularly furnished on the turret lathe.



Acme Universal Flat Turret Lathe equipped for turning Bevel Gears

* * *

SELLING WITH A PICTURE PROJECTOR

Most machinery salesmen carry photographs, charts, and drawings for use in explaining to prospective customers the various features of the products they sell. When these photographs, etc., are not bound together, they can hardly be kept in the desired sequence, with the result that the customer is likely to lose interest while the salesman attempts to find the desired illustrations. If a loose-leaf folder is used, the illustrations can be kept in the desired sequence, but there is always a bulky package or two for the salesman to carry.

Presenting a Sales Message by the Aid of a Projector

To assist the salesman in presenting his arguments and to decrease the amount of material that he must carry, the Bausch & Lomb Optical Co., Rochester, N. Y., has recently developed a still-film projector. For use in this device, volumes of catalogue illustrations, photographs, charts, and diagrams can be photographed into small film cartridges the same width as motion picture films. The different illustrations can be arranged on the film in the proper sequence to suit the talk of the salesman.

The tiny film pictures can be projected clear and sharp on any light wall surface or convenient sheet of paper; the darker the room, the larger the picture can be shown. Pictures 10 or 12 inches wide can be satisfactorily illuminated in well lighted rooms by selecting a wall on which the light does

not fall directly. If the room is fairly dark, pictures can be projected up to 3 or 4 feet wide, and in a completely darkened room, up to 9 feet wide. In addition to its application in selling, this device will also be found useful in giving lectures, etc.

This projector consists essentially of a light source and reflector, two condensing lenses, a projection lens that can be adjusted for focus, and a mechanism for holding the film flat and moving the successive pictures in front of the lens. A resistance cord is used to attach the instrument to any electric socket or outlet. The current is reduced to a voltage which can be handled by the small automobile headlight bulb used. All of the mechanism is enclosed in a housing of cast aluminum which is finished in black crystal enamel. The outfit weighs slightly under 5 pounds.

* * *

GRINDING TWO FACES OF CASTINGS SIMULTANEOUSLY

In the accompanying illustrations is shown a duplex ring-wheel grinding machine equipped with a rotary disk for feeding small iron castings between grinding wheels in such a way that two ends of the castings are ground simultaneously. After changing the feed disk for one on which the work-holding blocks or chucks are arranged on the periphery of the disk, at right angles to those shown, the machine is used for simultaneously grinding two sides of the same castings. Different feeding disks are used for 1/2-, 3/4-, and 1-inch sizes of the work. With the exception of the feeding disks, the machine is the standard No. 6 ring-wheel grinder built by Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill. It is equipped with 16- by 4- by 8-inch grinding wheels.

The castings are of a hard iron, and just enough stock is removed to obtain clean surfaces. An opening in one side of the castings is used for chucking them on the steel blocks already referred to. The operator simply places them on these blocks as the feeding disk revolves past him. At the back of the disk, the castings are carried down between the grinding wheels and dropped off at the bottom finish-ground on the two surfaces. The feeding disk is secured by means of three cap-screws to a collar on the end of its shaft. Both disks required for each size of box are made from gray iron castings that are machined all over. While the actual grinding is in process, the castings are held in place on the feeding disk by means of a circular spring-pressure bar mounted between the grinding wheels. This pressure bar is lined with removable hardened steel forms that can be replaced when worn out.

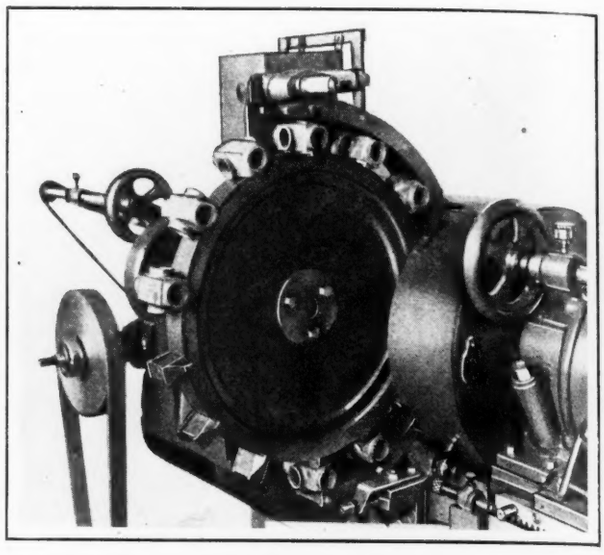


Fig. 2. Close-up View of the Feeding Disk which carries the Castings between Two Grinding Wheels

A 1/4-horsepower alternating-current motor running at 1800 revolutions per minute delivers power to the feeding disk, through reduction spur gears, a belt, a friction pulley, and worm-gearing. The feeding disk shaft is mounted in a box-pattern frame attached to a T-slotted pad on the front of the machine base. Production is said to range from 1600 to 2400 pieces finish-ground per hour, depending upon the size of the work.

The grinding heads mounted on the ends of the bed are driven by five-horsepower motors and are attached to plates which are adjustable along the bed by means of a rack and pinion movement. When the heads are set in a working position, they are rigidly clamped to the bed by anchor bolts that prevent spreading of the ways. The right-hand head is equipped with an aligning feature and with adjustments in four directions. A stop provides for resetting this head after dressing the wheels.

The wheel-dressing attachment is mounted on the rear of the bed, and is designed to swing between the grinding wheels. On thin work it is necessary to move back one head to permit the dresser to enter. Endwise movement of the dresser is controlled by means of a screw and crank handle. The cutters of the dresser are of the Huntington type and are locked on a special arbor.

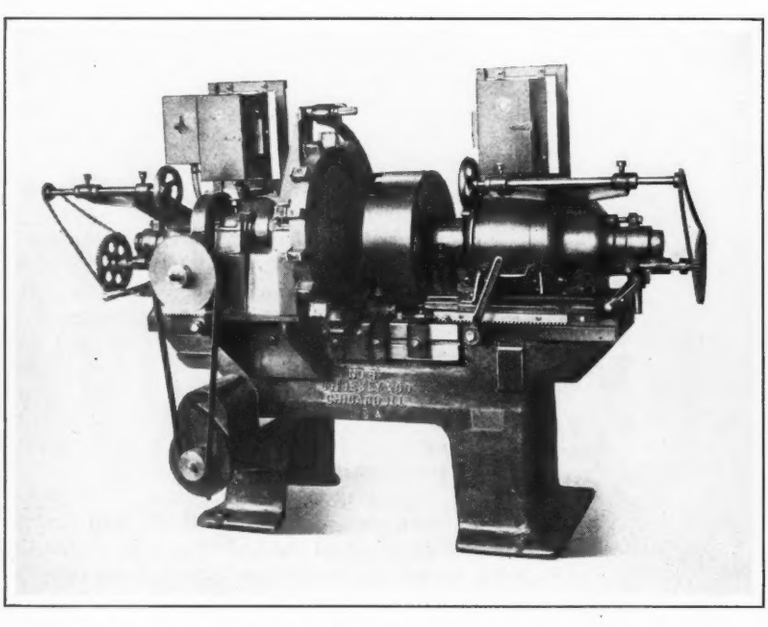


Fig. 1. Grinding Two Ends of Castings simultaneously on a Besly Machine

* * *

The useful purposes for which platinum may be employed in the industries are seriously interfered with by the recent fad of using platinum in jewelry. Fifteen years ago platinum was considerably cheaper than gold, and no one thought of using it as a setting for precious stones. During the early part of the war, when the Russian platinum supply was cut off from the rest of the world at the same time that the use of platinum in the industries increased, the price rose above that of gold, and immediately there was a demand for it for use in jewelry, as a substitute for gold. This again had the effect of increasing the scarcity and hence the price of platinum, so that it now is from four to five times as expensive as gold. The world's total output of platinum in 1924 was only about 88,000 ounces. In 1923, 106,000 ounces were used in jewelry alone. In the electrical industry, particularly, platinum, has many useful applications, but these are now largely limited by its high price.

TWELVE OPERATIONS IN FIVE SECONDS

Brass binder posts of the design shown at the top of the illustration Fig. 2, are produced at the rate of one every five seconds. This is done in the improved multiple-spindle, automatic screw machine built by the Davenport Machine Tool Co., Inc., Rochester, N. Y., which was described in November MACHINERY. For this job, the machine is equipped with cross-drilling, slotting, left-end threading, and milling attachments. Ten cuts are taken while the stock is held in the indexing work-head, and the other two after the part has been cut off and transferred successively to the left-end threading and milling attachments. In this way, seven separate pieces are worked on simultaneously with the resulting high production. The binder posts are produced from 1/2-inch stock, which is revolved at a speed of 236 surface feet per minute.

In this machine there are five indexing positions of the work-head which are referred to as positions A, B, C, D, and E. As any spindle indexes into position A, the stock is advanced against a stop, and in this position, hole *a*, Fig. 2, is drilled about 15/32 inch deep by means of a drill held in the corresponding tool-spindle. Then the stock is indexed into position B, where a flat-end drill is used to "bottom" hole *a*, chamfer this hole at end *b*, and face end *b*. This drill is held in the tool-spindle opposite position B. Simultaneously with these cuts, a form cutter held in the rear tool arm, reduces the diameter of shank *c*. In position C, hole *a* is threaded by a tap held in the corresponding tool-spindle, and shank *c* is sized by a form tool on the rear tool-slide.

When the stock is indexed into position D, the work-spindle stops revolving so as to permit cross-drilling the two holes *d* and cutting slots *e* within close limits, simultaneously. For these cuts, a drill and a slitting saw are held in the cross-drilling and slotting attachments, respectively. The tool-spindle corresponding to position D is advanced by its feed-cam lever to swing the revolving slitting saw into the work the required amount, while the feed-cam lever also pushes rod *A*, Fig. 1, forward to actuate a rack mechanism that feeds and withdraws the drill. Power for driving the drill and the saw spindle is taken from the same source at the rear of the machine.

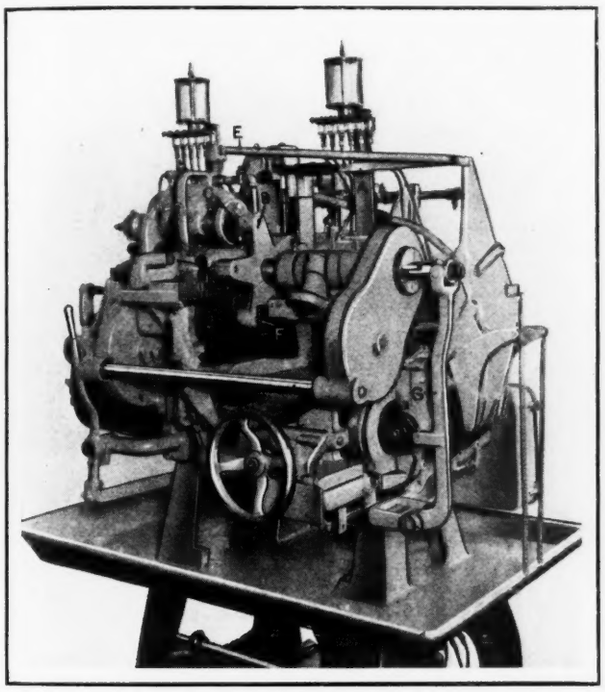


Fig. 1. Multiple-spindle Automatic Screw Machine equipped for turning out, every Five Seconds, a Brass Piece on which Twelve Cuts are taken

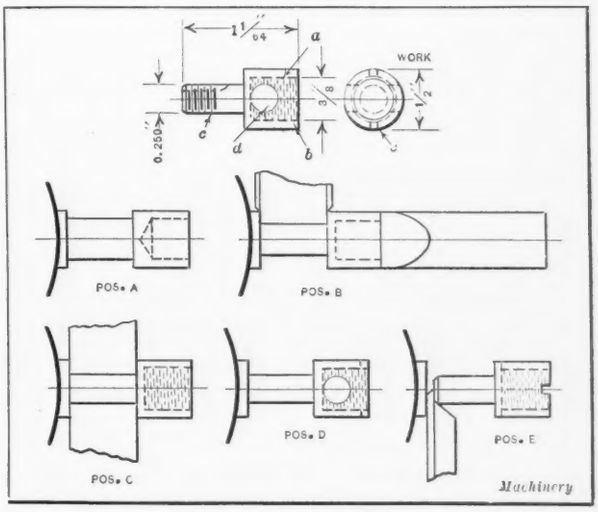


Fig. 2. Diagrams of the Work and of the Different Positions of the Work-head

In position E the piece is cut off, and while this step is in process, work-carrier *B* is advanced to slip a collet over the large end of the part. The work-carrier has five fingers equipped with collets, and is indexed synchronously with the work-head. When the part has been cut off, carrier *B* raises it into line with a spindle at *C*, which is equipped with a die-head for threading shank *c*, Fig. 2. This die-head is opened and closed by means of a rod which connects the mechanism to the feed-cam lever for the tool-spindle of position C.

At the next indexing of the carrier and work-head, the part is carried down in line with the milling cutter *D*, Fig. 1, for milling the keyway in the shank. The feed of the milling cutter is obtained through rod *E*, which connects the attachment to the cam-feed lever for the tool-spindle corresponding to position D of the work-head. In the next indexed position of the work-carrier, a small-diameter rod attached to block *F* is advanced to eject the work from the carrier collet that happens to be opposite this rod.

The work-carrier is operated forward and backward by means of lever *G* which is actuated by a cam on the feed-cam shaft of the machine. At a certain point on the shaft of the work-carrier, annular grooves are cut which mesh with a small pinion mounted on a shaft that is inclined on the front side of the carrier. From this source, power is derived for advancing and withdrawing block *F* at twice the longitudinal feeding rate of the carrier.

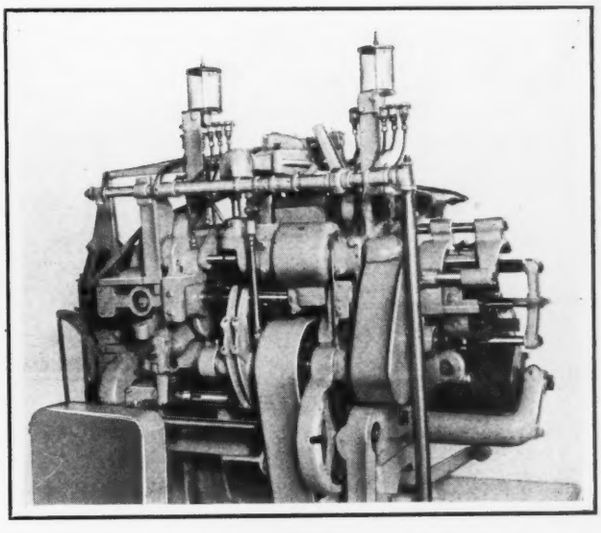


Fig. 3. Rear View of the Machine used in producing the Brass Binder Posts

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No. 496 Improved Universal Bevel Protractor
—with Acute Angle Attachment

—particularly adapted for laying out small angles

No. 811 Rex Outside and No. 812 Rex Inside Spring Calipers

—handy, inexpensive calipers

Vernier Calipers
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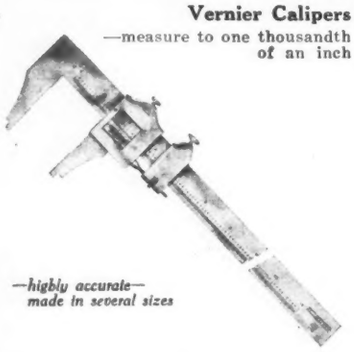

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"Up-to-the-Minute" in Design

That's why a mechanic invariably chooses Brown & Sharpe Tools. He knows that the name Brown & Sharpe is synonymous with the last word in tool design and accuracy.

He knows that Brown & Sharpe Tools are his standards and without them he cannot accomplish his best work. Consequently, he insists on those tools that for over three generations have been the choice of mechanics the world over—Brown & Sharpe Tools.

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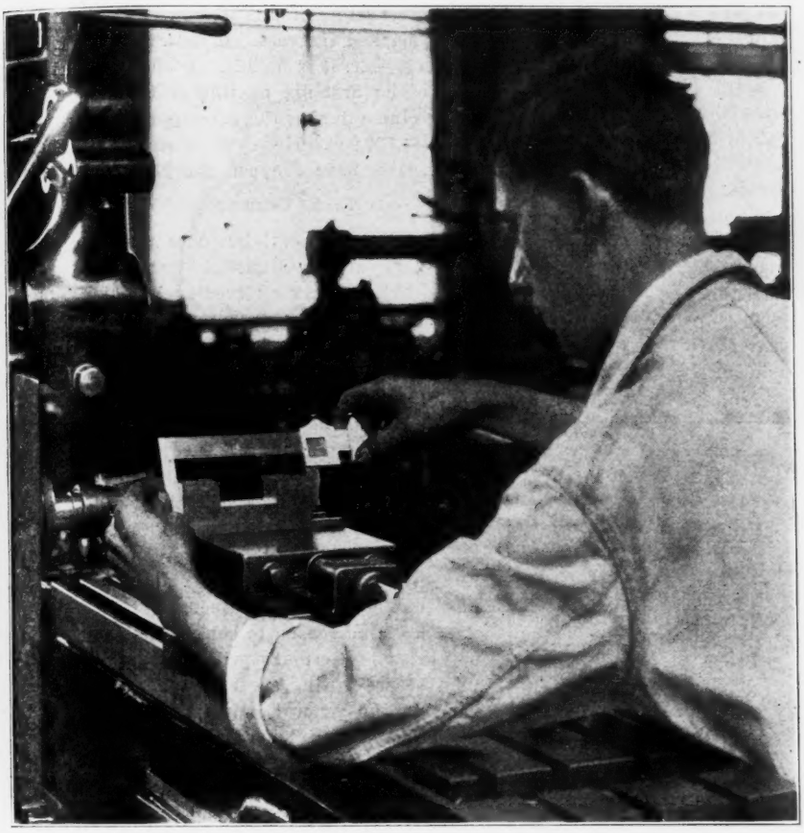

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—furnished singly and in sets.

—a favorite inexpensive, accurate tool.

Combination Set
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—a handy, modern tool for Diemakers or Patternmakers.

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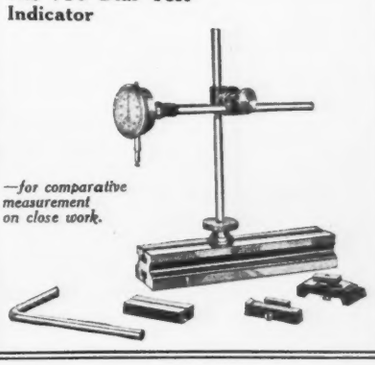


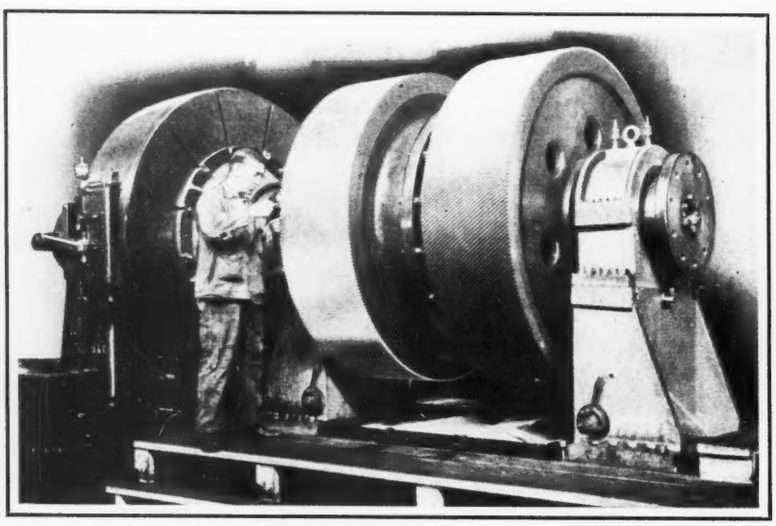
—for comparative measurement on close work.

& SHARPE

HOBBING A LARGE HERRINGBONE GEAR

One of the largest single-reduction herringbone drive gears ever made for a generator is shown in the accompanying illustration. The operator is seen measuring one tooth for thickness by using a gear-tooth vernier. This gear was produced on a special hobbing machine at the Lynn, Mass., plant of the General Electric Co., and will be used in connection with a turbine and generator in a paper mill. The pedestals on the bed of the hobbing machine were provided with special bearings in which the gear turned while being cut. After the gear journals were dropped into these bearings, and an indicator was used to see that the gear ran true at all points, the bearing caps were bolted down and the gear was then bolted to the fixture on the faceplate of the machine. After a second check, the cutting commenced.

The machine was kept in constant operation until the job was finished, since it would have been impossible to stop it without affecting the accuracy required for a gear of this type. Four weeks, or 672 hours, were consumed in cutting



Cutting a Herringbone Gear which has a Wide Space between the Helixes

the gear. It was necessary to have the journals run true within 0.0005 inch and to keep the room at an even temperature. The important specifications of the gear are as follows: Number of teeth, 296; pitch diameter, 74 inches; outside diameter, 74.410 inches; angle of helix, 35 degrees; width of each face, 20 inches; total width, including the space between the helixes, 58 inches; and estimated weight, 36,000 pounds.

* * *

PROSPECTS FOR AMERICAN MACHINE TOOLS IN GERMANY

According to information obtained by the Department of Commerce from Trade Commissioner Theodore Pilger, Berlin, Germany, there has recently been a very sharp change in the German demand for American machine tools, and although a few months ago American exports of such equipment to Germany were flowing in large volume, it appears probable that this trade will not be sustained. While there appears to be ample demand for these tools in that market, present conditions cripple business and suggest that this trade will be seriously affected.

Past Experience in German Market Reviewed

A brief review of past experience in this market will make the present situation clearer. On the average, during the five years 1909 to 1913, inclusive, Germany absorbed $2,280,000 worth of American metal-working machinery. During the war this trade collapsed, and following the Armistice the volume was very small because of import embargoes imposed by Germany. During the period of these embargoes a certain small volume of business was possible if special import licenses were secured. The imports during the period 1919 to 1923 were as follows: 1919, $8746; 1920, $144,192; 1921, $118,398; 1922, $77,120; 1923, $209,474.

In the latter part of 1924, this embargo was lifted with the result that the total business for that year was $545,315. In 1925, there was a marked increase. Comparing only the first six months of each year, it is noted that while the shipments to Germany in the first six months of 1924 approximated $210,000, the volume during the corresponding period of 1925 was nearly $1,500,000. However, since about the first of August these sales have dropped sharply.

Long Credit Terms Demanded

This is a reflection of the general business condition in Germany. Many dealers are pessimistic. Customers are still willing to buy, but are asking credit exceeding six months or one year, which is practically impossible. Many potential purchasers are in such a financial condition that they will probably have to undergo reorganization, and therefore do not constitute good credit risks.

It should be noted that German machinery manufacturers have seen the new types of special machines which have met with a good market during the early months of 1925, and are rapidly bringing out copies which can be sold at a lower price, even though their effectiveness and reliability have not been demonstrated.

There is no reason to believe that machinery sales in Germany will increase in volume before spring, as an earlier improvement in the general industrial situation is not probable. In general, business does not depend so much on the prices quoted as upon the terms offered, but the business better be declined unless some arrangement can be made under which American manufacturers by group effort are continuously able to obtain credit information and keep in touch with local conditions to an extent that would justify the sale of equipment on credit or the handling of stocks on some safe consignment basis.

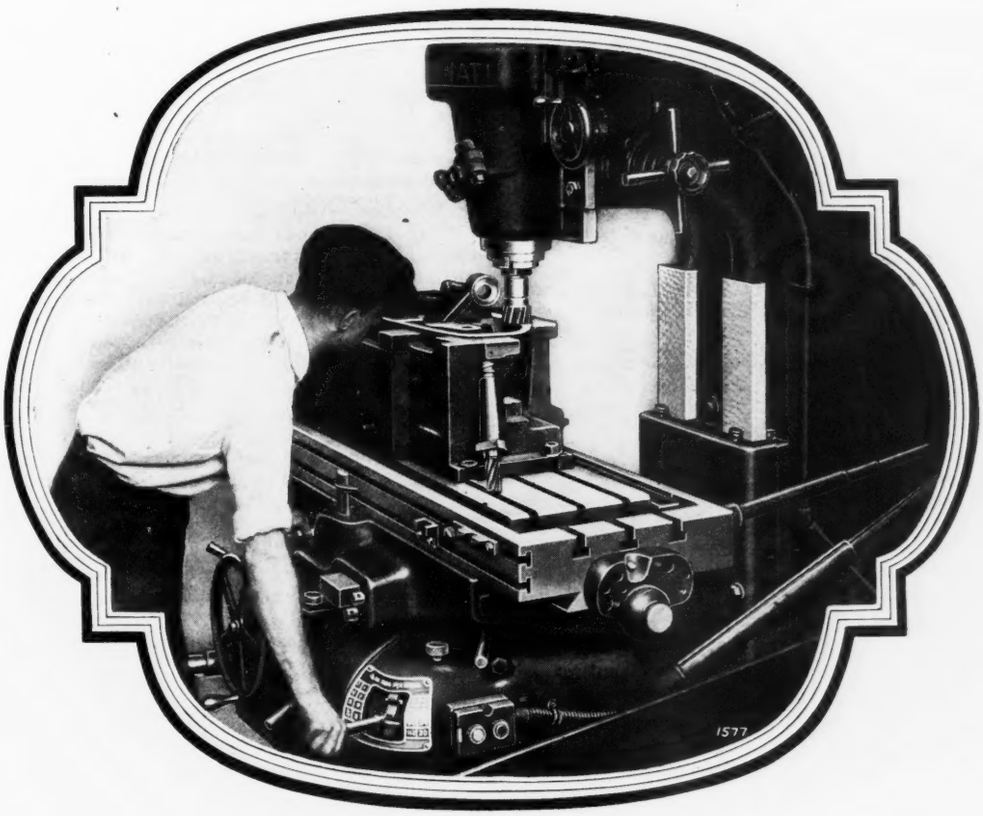
It also appears that since the embargoes were lifted on October 1 and the new German tariff came in operation, the German banks are restricting credit if it is to be used to cover import transactions. Probably, from the German point of view, this is a necessary policy, although it restricts American business. Nevertheless, it will probably be a necessary policy until the German balance of trade is turned and exports exceed imports.

Much of the machinery that has been imported has been for German manufacturers of automobiles, but these manufacturers are still uncertain as to their ability to compete with foreign cars, even though their product is protected by a high tariff. Consequently, they are maintaining a careful watch over their costs and will continue to do so until they know definitely their actual position. Therefore, for the time being they are not buying new machinery.

It should also be remembered that some of the rush of the American machinery business that developed during the past spring and summer was due to the fact that the dealers were stocking up and this stock has not yet been sold to manufacturers.

American Machinery Needed

Unquestionably the industries of Germany are in need of American machinery. In pre-war years they depended on this equipment to a great degree, but it has not been readily available to them for nearly a decade. As Mr. Pilger stated, German customers have the desire to buy, but it remains to be seen whether business conditions will make it possible for them to do so.



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PERSONALS

P. J. RICCOBENE has recently joined the home office sales organization of the Uehling Instrument Co., 473 Getty Ave., Paterson, N. J.

C. R. BURT, general manager of the Pratt & Whitney Co., Hartford, Conn., was recently elected a member of the board of directors and made vice-president of the company.

P. E. SEIBEL has joined the sales department of the Triplex Machine Tool Co., 50 Church St., New York City, dealer and manufacturers' representative of machinery and tools.

WILLIAM M. JAMES, formerly superintendent of the Walker-Vehicle Co., Chicago, Ill., has recently joined the Kearney & Trecker Corporation, Milwaukee, Wis., in the capacity of works manager.

A. G. HERTZLER, for many years associated with the Bearings Co. of America, Lancaster, Pa., has recently become connected with the sales department of the Pacific Sheet Steel Corporation, of South San Francisco, Cal.

F. M. CROSS, formerly manager of the New York pneumatic tool department of the Ingersoll-Rand Co., 11 Broadway, New York City, has been appointed manager of the pneumatic tool department for the Chicago territory with headquarters at Chicago.

W. E. BROWN has been appointed district manager of the central station department, New York district, of the General Electric Co., with offices at 120 Broadway, New York City. Mr. Brown was manager of the Schenectady local office of the New York district.

EDWARD E. ROBERTS has become associated with the Firth-Sterling Steel Co., 310 Hudson St., New York City, and will travel exclusively in the western part of New York state, with a view to giving better service to customers of the company in Buffalo and vicinity.

P. M. BROTHERHOOD, 25 Church St., New York City, announces the opening of a Buffalo office. P. M. Brotherhood, Jr., who was manager of Manning, Maxwell & Moore's Buffalo office, is in charge of the new branch, with headquarters at 7 Ashland Ave., Buffalo, N. Y.

W. H. PATTERSON, formerly vice-president of the Kaestner & Hecht Elevator Co. of Chicago, has joined the industrial sales department of the Westinghouse Electric & Mfg. Co. at East Pittsburg, Pa. Mr. Patterson will be in charge of the building industries division of the department.

JAMES R. THOMPSON has been appointed works manager of the Trafford Foundry of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Mr. Thompson has been with the Westinghouse organization nearly thirty years, and has served for the last four years as assistant works manager of the Trafford Foundry.

H. I. MARKEY has recently been made district manager for the Diamond Chain & Mfg. Co., Indianapolis, Ind., of the New York territory, with offices at 1011 Chestnut St., Philadelphia, Pa. FRANK SMILEY succeeds Mr. Markey as district manager of the west central territory, and is located at 855 Leader-News Bldg., Cleveland, Ohio.

PHILIP A. LANG, of London, England, special European representative of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., and for many years works manager at East Pittsburg, has come to the United States to consult with officials of the company in East Pittsburg and New York. Mr. Lang expects to remain in this country for two months.

H. TERHUNE, who for many years was connected with the Billings & Spencer Co., Hartford, Conn., and later with the Chambersburg Engineering Co., Chambersburg, Pa., has joined the sales staff of the Erie Foundry Co., Erie, Pa., builder of forge shop equipment, including steam forging hammers, board and steam drop-hammers, trimming presses, etc.

WILLIAM G. CLYDE has been elected president of the Carnegie Steel Co., Pittsburg, Pa. Mr. Clyde was sales manager of the American Steel Hoop Co. of Philadelphia at the time that that company was taken over by the Carnegie Steel Co. He was later made assistant general sales manager of the latter company, and in 1918 became vice-president and general manager of sales.

G. W. MEAD, formerly president of the Linde Air Products Co., 30 E. 42nd St., New York City, was elected chairman of the board of directors at the last meeting of the board. W. F. BARRETT, formerly vice-president, was elected to the presidency; RALPH R. BROWNING was elected vice-president in charge of sales activities; and J. A. RAFFERTY, vice-president in charge of engineering, manufacturing, and research.

FRED D. SWEET has been appointed manager of the middle western territory of the Oil Jack Co., Inc., 1457 Broadway, New York City. Mr. Sweet's offices will be in the Wrigley Bldg., Chicago, Ill. He was formerly manager of the U. S. Rubber Co. in the handling of automotive equipment, sales supervisor of the Biflex Products Corporation, and secretary and general sales manager of the Steel Products Corporation.

W. C. FURNAS has been appointed superintendent of the maintenance department of the Allis-Chalmers Mfg. Co., Milwaukee, Wis., succeeding the late C. O. Barrie. Mr. Furnas first became associated with the Allis-Chalmers Mfg. Co. in 1910, and has since served in various departments of the company. He recently returned from a trip to England, Scotland, and the Continent, where he spent four months studying European shop methods.

M. J. CARNEY, formerly president of the Prest-O-Lite Co., Inc., 30 E. 42nd St., New York City, was elected chairman of the board of directors at a recent meeting. WILLIAM F. BARRETT, formerly vice-president, was elected to the presidency; RALPH R. BROWNING was elected vice-president in charge of acetylene sales activities; and R. J. HOFFMAN was re-elected vice-president in charge of the storage battery and automotive divisions.

L. A. CARTER, for the last twelve years associated with the Lehmann Machine Co., St. Louis, Mo., as chief engineer, and for several years president of the company, has gone into business for himself as a consulting mechanical engineer. Although no longer officially connected with the Lehmann Machine Co., Mr. Carter is acting as consulting engineer for the company and his office is located in their plant at 3560 Chouteau Ave., St. Louis.

GEORGE L. ERWIN, JR., has been appointed sales manager for the Kearney & Trecker Corporation, Milwaukee, Wis. He is a graduate of Cornell University, student apprentice at the Putnam Machine Works, and was salesman for Manning, Maxwell & Moore at their St. Louis office, and salesman for the Kearney & Trecker Corporation at the Chicago office. For the last two years he has been advertising manager at the home office of the Kearney & Trecker Corporation. His new duties will include his former ones, combining advertising with sales direction.

J. H. WHITING has been elected chairman of the board of the Whiting Corporation, Harvey, Ill. Colonel T. S. HAMMOND, who for many years has been vice-president and secretary, succeeds Mr. Whiting as president and treasurer. R. A. PASCOE will take Colonel Hammond's place as secretary, and R. H. BOURNE, vice-president and sales manager of the company, succeeds Colonel Hammond as president of the Grindle Fuel Equipment Co., a subsidiary of the Whiting Corporation. N. S. LAWRENCE, vice-president and assistant sales manager of the Whiting Corporation, is president of the Swenson Evaporator Co., another subsidiary of the Whiting Corporation. J. H. Whiting will remain actively engaged in the business. No change of policy is involved on the part of the Whiting Corporation and the subsidiaries referred to.

OBITUARIES

JOSIAH FRANCIS JOHNSON, manager of the General Engineering Division of the South Philadelphia Works of the Westinghouse Electric & Mfg. Co., died suddenly in the Chester Hospital on November 12, from a cerebral hemorrhage. Mr. Johnson was born July 15, 1879 at Ziongrove, Pa. In 1905 he graduated from the Pennsylvania State College with high honors, and following his graduation entered the employ of the Westinghouse Electric & Mfg. Co. in East Pittsburg, with which he has since been associated in various engineering capacities.

ALLEN A. TIRRILL, an inventor and consulting engineer of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., died recently at the age of fifty-two. Mr. Tirrill was associated for many years with the General Electric Co., and in 1910 became an engineer with the Westinghouse Electric & Mfg. Co. In 1916 he left that company, but since that time has been one of its consulting engineers. Mr. Tirrill was the inventor of a voltage regulator bearing his name.

JAMES CHARLES POTTER, vice-president of the Potter & Johnston Machine Co., Pawtucket, R. I., died on October 30.

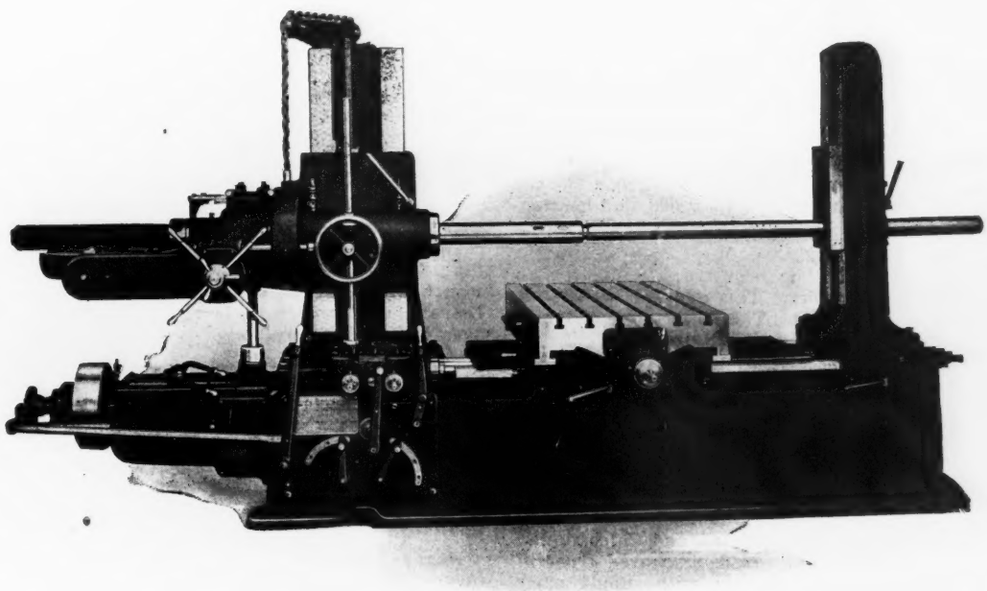
"A man's worth is measured by the degree of supervision he requires" Similarly, a machine's worth is affected by the amount of checking up required of the operator.

The LUCAS

"PRECISION"

Boring, Drilling and Milling Machine

is ACCURATE and DEPENDABLE



We also make the LUCAS Power Forcing Press

Horse power costs less than Man power

THE LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF CLEVELAND, OHIO, U.S.A.

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry, Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. V. Lowener, Copenhagen, Oslo, Stockholm. R. S. Stokvis & Zonen, Paris and Rotterdam, Andrews & George Co., Tokyo.

TRADE NOTES

HUBBARD STEEL FOUNDRY CO., East Chicago, Ind., has recently completed a large machine shop equipped with modern machines.

CHARLES M. HOFFMAN CO., Kansas City, Mo., will represent the Oil Jack Co., Inc., 1457 Broadway, New York City, in the southwestern district.

CLEVELAND AUTOMATIC MACHINE CO., Cleveland, Ohio, has opened an office at 95 Liberty St., New York City. A. W. Schafer is district manager in charge of the New York office.

EUREKA TOOL & MACHINE CO., 42 Walnut St., Newark, N. J., announces that it has taken Edward W. Weiler into the firm. Mr. Weiler will develop the machine design side of the business.

GISHOLT MACHINE CO., 1300 E. Washington Ave., Madison, Wis., has moved its New York office to 2 Rector St., Room 502. R. D. Heflin, New York district manager for the last ten years, continues in charge.

UNION MFG. CO., New Britain, Conn., has appointed the Strong, Carlisle & Hammond Co., of Cleveland, Ohio, its sole distributor in that territory for the company's complete line of lathe, drill, and planer chucks.

UNITED STATES ELECTRICAL TOOL CO., Cincinnati, Ohio, announces that U. S. portable electric tools will be handled by and through Westinghouse service stations, located in twenty-eight cities throughout the United States.

CINCINNATI BALL CRANK CO., Cincinnati, Ohio, has awarded a contract to the Austin Co., Cleveland, Ohio, for the construction of an addition to its machine shop, of 90 by 70 feet. The new building will be a steel frame construction, one story high.

BROWN INSTRUMENT CO., 4532 Wayne Ave., Philadelphia, Pa., announces the opening of the following offices: 215 E. New York St., Indianapolis, Ind., with J. R. Green in charge; Room 1108, Hippodrome Bldg., Cleveland, Ohio, with G. S. Frazee in charge.

FOOTE BROS. GEAR & MACHINE CO., 232-242 N. Curtis St., Chicago, Ill., has appointed the Power Equipment Co., 315 Third Ave., N., Minneapolis, Minn., representative for the sale of Foote Bros. industrial gears, spur, worm, and herringbone speed reducers.

KUHLMAN ELECTRIC CO., Bay City, Mich., has awarded a contract to the Henry G. Webber Construction Co. for an addition to the Kuhlman factory. This addition will measure approximately 75 by 250 feet. The larger sizes of transformers will be produced in the new building.

DAVIS KEYSEATER CO., Rochester, N. Y., who two years ago took over the good will and manufacturing rights of the Davis keyseater business of the W. P. Davis Machine Co., has recently purchased the patents and good will of the keyseater manufactured by the C. F. Davis Machine Co., of Rochester, N. Y.

SLEEPER & HARTLEY, INC., 335 Chandler St., Worcester, Mass., has taken over the spring coiling machinery department of the American Can Co., New York and Chicago, and is now prepared to furnish to the trade improved types of these spring coiling machines, together with supply parts and repair parts for the machines in use.

OAKLEY CHEMICAL CO., 26 Thames St., New York City, will hold its ninth annual conference on industrial cleaning on December 7 to 10, when the field service men from the various parts of the United States and Canada will meet together at the general offices of the company to exchange experiences and read and discuss technical papers on different phases of cleaning.

JOSEPH T. RYERSON & SON, INC., 16th and Rockwell Sts., Chicago, Ill., announces that it has recently received the largest single order for nail-making machinery that has been placed in recent years. The order was placed by the Bethlehem Steel Co., and was for 124 Ryerson-Glader steel frame nail machines and 16 Ryerson-Glader barbed wire machines, for use in the company's new plant at Sparrow Point, Md.

P. B. YATES MACHINE CO., Beloit, Wis., and the AMERICAN WOODWORKING MACHINE CO., Rochester, N. Y., have been combined under the name of YATES-AMERICAN MACHINE CO. J. E. McKelvey, who has been president of the American Woodworking Machine Co. since its organization in 1901, and P. G. Farrow, vice-president and general manager of the P. B. Yates Machine Co., will retain their respective positions in the new company.

LYON IRON WORKS, Greene, N. Y., has added to its products a line of material handling equipment including skid platforms, industrial trailers, factory and warehouse trucks, casters, and similar units. The new line of products is distributed through Fink-Dumont-White, Inc., 405 Lexington Ave., New York City. F. P. Fink is vice-president of the company; R. B. Dumont, secretary and treasurer; and George G. Raymond, president and general manager.

MILWAUKEE ELECTRIC CRANE & MFG. CO., INC., Milwaukee, Wis., has been reorganized under the laws of the state of Wisconsin as the MILWAUKEE ELECTRIC CRANE & MFG. CORPORATION. The new corporation has acquired all the property and business of its predecessor and is preparing to increase its business and extend its field of operations. The officers are as follows: President, M. A. Beck; vice-presidents, Henry S. Wright and A. J. Pitman; and secretary-treasurer, M. P. O'Brien.

BREESE BROS. CO., Cincinnati, Ohio, has recently let contracts for an addition to its plant. The new building will be two stories high, and is to be of brick and steel construction, with concrete floors. The additional floor space made available will be 30,000 square feet, making a total of about 100,000 square feet of floor space. Arrangements have been made to install additional machinery which will permit heavier work to be handled in the fabrication of sheet-steel products.

MILES MACHINERY CO., dealer in new and used machinery, is moving into new and larger quarters at 900-922 S. Niagara St., Saginaw, West Side, Mich. The new plant contains about 25,000 square feet of floor space, and will house the storage warehouse, rebuilding shops, and offices. Particular attention has been given to arranging and equipping the machine shop for rebuilding used machinery, and many new appliances have been added for remachining and testing machine tools.

DRIVER-HARRIS CO., Harrison, N. J., has purchased the works and properties of the ELECTRICAL ALLOY CO., at Morristown, N. J. The Morristown plant will be operated as the Electrical Alloy Division of the Driver-Harris Co., and the main executive offices and sales department will be at Harrison. The added productive capacity will greatly increase the company's facilities and will enable it to render service and make shipments in quantities sufficient to meet the present demand.

PRODUCTION MACHINERY SALES CO., 628 Ford Bldg., Detroit, Mich., has been formed to deal in die-casting machinery and tool-room and production machine tools, as well as woodworking machinery, special machinery, and dies. The company invites correspondence from manufacturers wishing to be represented in Detroit. Friedrich Fiesselmann, who was sales manager for the Riverside Machinery Depot, Detroit, for seven years, is vice-president and general manager of the company.

UEHLING INSTRUMENT CO., 473 Getty Ave., Paterson, N. J., has appointed the Ernest E. Lee Co., 115 S. Dearborn St., Chicago, Ill., representative of the company in northern Illinois and northern Indiana in connection with the sale of carbon-dioxide recorders, fuel waste meters, and other power plant instruments. The Coon de Visser Co., which has been representing the Uehling Instrument Co. for several years in Michigan, has moved from 1772 W. Lafayette Boulevard to 2051 W. Lafayette Boulevard, Detroit, Mich.

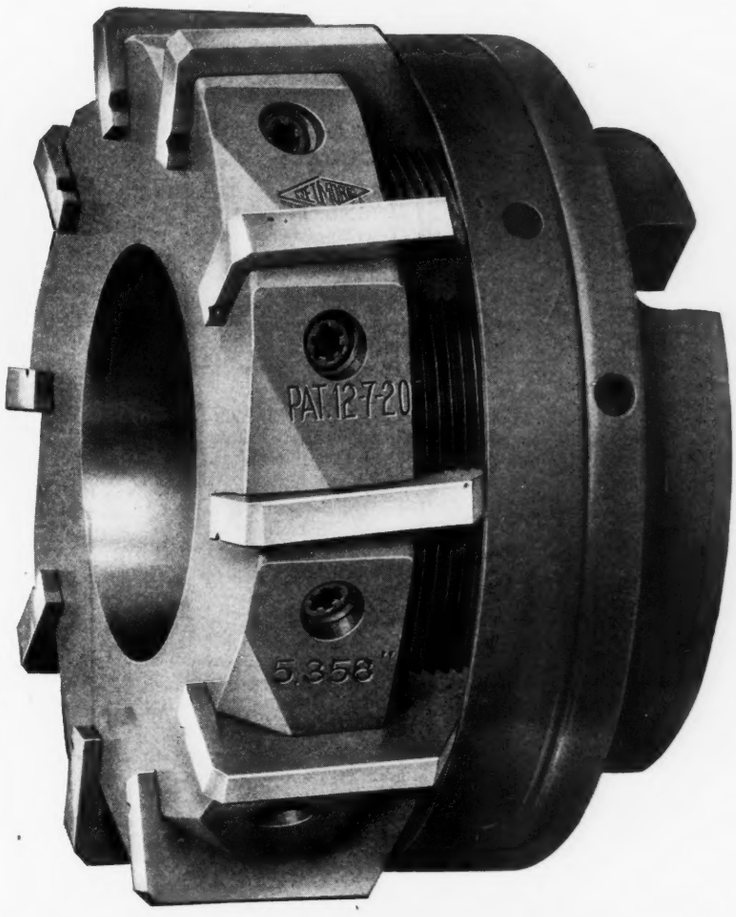
HENRY DISSTON & SONS, INC., Philadelphia, Pa., manufacturers of saws, files, and tools, announce that their Australian branch has been moved to larger quarters in a new two-story factory and sales office building at Camperdown, Sydney, N. S. W. This branch is provided with complete equipment for manufacturing saws and knives from steel furnished from the Disston Works in Philadelphia, and for doing all kinds of repair work. The Disston organization also includes an English Disston company at London, England, a factory and sales organization in Toronto, Ontario, Canada, and branches in Vancouver and the principal cities of the United States.

* * *

STANDARDIZED DESIGN FOR FREIGHT CARS

Plans to standardize all types of freight cars in use on the railroads of this country have been announced by the Board of Directors of the American Railway Association. The board has authorized the mechanical division of the American Railway Association to work out designs for a standard car for various types of equipment, including automobile, stock, hopper, and gondola cars. Single-sheathed and double-sheathed steel frame box cars have already been standardized. The standardization of box cars will result in a substantial saving to the railroads, both in buying new equipment and in the cost of maintenance. By having designs standardized, car builders can keep on hand drawings, dies, and patterns for these cars, thus doing away with much of the preliminary engineering costs attending the placing of orders for new equipment.

A distinctive feature of this Wetmore Shell Reamer is the ⅛" projection of the blades over the end of the reamer body for chip clearance. This allows the chips to fall off ahead of the reamer body and prevents chips from clogging up along cutting edge of blades.



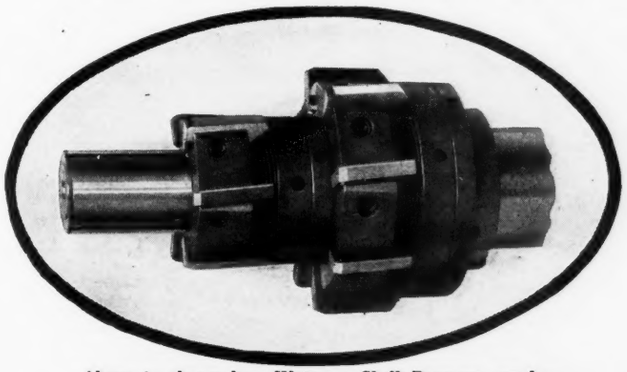
Wetmore Shell Reamers have .087" expansion. Made in these sizes: 1¼" to 3", 6 blades; 3-1/16" to 5", 8 blades; 5-1/16" to 6", 10 blades. Larger sizes made on order. Made also with straight hole, if desired. Sizes above 2½" readily adaptable for line reaming.

Why Big Plants Specify WETMORE Shell Reamers

More than one user has told us that Wetmore Shell Reamers have done work they thought would be too much for any reamer.

But Wetmore Reamers have the habit of making good on hard jobs. We guarantee them to lower your production costs. They do faster work; they stand up longer; blade replacement costs are lower.

Wetmore Shell Reamers are adaptable for either line or pilot reaming. Body, lock nut, and cone nut are finest alloy steel, heat-treated. Left-hand angle blades are staggered to eliminate chattering.



Above is shown how Wetmore Shell Reamers can be adapted for pilot reaming in combination or single.

Send for Free Catalog

—showing full line of standard, heavy-duty, shell, small machine and cylinder reamers, arbors, replacement blades. Sent free—postpaid.

WETMORE REAMER CO.
Milwaukee, Wisconsin

WETMORE EXPANDING REAMERS

"THE BETTER REAMER"

COMING EVENTS

NOVEMBER 30–DECEMBER 4—Annual meeting of the American Society of Mechanical Engineers at the Engineering Societies Building, 29 W. 39th St., New York City. Calvin W. Rice, secretary.

NOVEMBER 30–DECEMBER 5—Fourth national exposition of power and mechanical engineerjng to be held in the Grand Central Palace, New York City.

JANUARY 9-16—National Automobile Show to be held at the Grand Central Palace, New York City.

JANUARY 11-13—Second World Motor Transport Congress to be held in New York City during the National Automobile Show. Sponsored by the National Automobile Chamber of Commerce, 366 Madison Ave., New York City.

JANUARY 20-22—Annual meeting of the Society of Automotive Engineers to be held in Detroit, Mich. Coker F. Clarkson, secretary, 29 W. 39th St., New York City.

JANUARY 21-22—Winter sectional meeting of the American Society for Steel Treating at Buffalo, N. Y. Secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

JANUARY 30–FEBRUARY 6—National Auomobile Show, to be held at the Coliseum, Chicago, Ill.

NEW BOOKS AND PAMPHLETS

THOMAS' REGISTER OF AMERICAN MANUFACTURERS (1925-1926). 4500 pages, 9 by 12 inches. Published by the Thomas Publishing Co., 461 Eighth Ave., New York City. Price, $15.

This is the sixteenth edition of this well-known purchasing guide covering all the manufacturers and manufactured products in the United States. The arrangement is the same as in previous editions, the first section comprising a finding list and index covering 178 pages. The second section, which is the main part of the book, contains a list of manufacturers, classified according to business, and covers 3560 pages. The products are arranged alphabetically, and under the products the firm names are arranged, again alphabetically, according to states. The third section, covering 461 pages, comprises an alphabetical list of the manufacturers, giving home offices, branches, etc. The fourth section, containing an alphabetical list of all the trade names, brands, etc., of the products classified in the directory, fills 352 pages. The fifth section, comprising an appendix, contains a list of banks, boards of trade and other commercial organizations, and leading trade papers. The various sections, as in previous editions, are printed on different colored paper, so that they can be readily referred to. The index list is printed on yellow; the classified list of manufacturers, on white; the alphabetical list of manufacturers, on blue; and the trade name section, on pink paper.

NEW CATALOGUES AND CIRCULARS

RECORDING PYROMETERS. Brown Instrument Co., Philadelphia, Pa. Bulletin 1-13, illustrating and describing a new design of recording pyrometer which has recently been developed by this concern.

ELECTRIC FITTINGS. Crouse-Hinds Co., Syracuse, N. Y. Circular illustrating tumbler switch condulets of the FA series, for use in industrial plants or wherever switches are subjected to severe conditions.

ALLOY STEELS. Central Steel Co., Massillon, Ohio, is distributing free a celluloid disk, by means of which the constituents and heat-treatment for different grades of "Agathon" steels can be readily found.

STOKERS. American Engineering Co., Philadelphia, Pa. Catalogue descriptive of the Taylor stoker. In addition to containing a complete description of these stokers, the book illustrates a number of installations.

VOLTAGE REGULATORS. General Electric Co., Schenectady, N. Y. Bulletin GEA-123, containing information on the construction, operation, and application of General Electric automatic generator voltage regulators.

MILLING MACHINES. Kearney & Trecker Corporation, Milwaukee, Wis. Circular entitled "A Few Interesting Facts about K & T Double Over-arms," describing the construction of the double over-arm provided on Milwaukee milling machines.

GEAR SHAPERS. Fellows Gear Shaper Co., Springfield, Vt. Booklet entitled "A New Development in Gear Cutting," descriptive of a new type of high-speed gear shaper. The construction and operation of the new machine are described in detail.

WIRE STRAIGHTENING MACHINES. Baird Machine Co., Bridgeport, Conn. Circular descriptive of some of the automatic machine accessories made by this concern, including wire straighteners, metal and wire reels, and tool and die grinders.

CIRCUIT-BREAKERS. Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Circular 1705-A, containing data on Westinghouse type CL carbon circuit-breakers, designed especially for 250-volt industrial applications where a compact breaker is required.

REELS AND SPOOLS FOR THE WIRE INDUSTRY. Mossberg Pressed Steel Corporation, Attleboro, Mass. Catalogue 102, showing typical examples from this company's line of pressed-steel reels and spools and other appliances for the wire industry.

MECHANICAL MOTION AND ELECTRICAL OPERATION RECORDERS. Bristol Co., Waterbury, Conn. Catalogue 1600, descriptive of Bristol mechanical motion and electrical operation recorders for application to machinery, elevators and hoists, conveyors, etc.

ELECTRIC MOTORS. Reliance Electric & Engineering Co., 1056 Ivanhoe Road, Cleveland, Ohio. Bulletin 4000, illustrating and describing in detail the direct- and alternating-current, ball and roller bearing motors made by this concern.

CRUCIBLES. Plumbago Crucible Manufacturers' Publicity Bureau, Room 1506, 90 West St., New York City. Circular entitled "How to Cut Crucible Costs," containing suggestions for the storing, handling, and use of plumbago crucibles.

CENTRIFUGAL PUMPS. De Laval Steam Turbine Co., Trenton, N. J. Pamphlet describing the steam-turbine-driven centrifugal pumping units made by this company for use in connection with the water supply system of Tulsa, Okla., which has a capacity for delivering more than 28,000,000 gallons of water daily.

UNIVERSAL TURRET LATHES. Foster Machine Co., Elkhart, Ind. Case No. 7 in the Foster Production Engineering series shows the tooling employed on the Foster 3-B universal turret lathe for machining a cast-iron part for a gasoline filling station pump. Specific figures are given regarding the savings effected with this equipment.

BRASS. Bridgeport Brass Co., Bridgeport, Conn. Pamphlet commemorating the sixtieth anniversary of the company, which was started in 1865. The pamphlet contains much of historical interest relating to the industry. One of the interesting sections describes the developments in brass-working machinery that have taken place in the last half century.

STELLITE. Haynes Stellite Co., 30 E. 42nd St., New York City. Booklet entitled "Properties of Haynes Stellite," containing information on the hardness, resistance to abrasion, strength, coefficient of friction, electric and thermal conductivity, and other properties of the three grades of Haynes stellite in common use. The information given should make it possible to select the grade best fitted for the requirements.

FORGING MACHINERY. National Machinery Co., Tiffin, Ohio. Catalogue entitled "Carrying the Second Exposition of Forging Machinery to the Man Unable to Attend," containing pictures showing views of the exposition held by the company August 24 to 27, as well as illustrations of the improved types of forging machines exhibited and examples of their work. A brief description of the exhibits is included.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly at New York, N. Y., for October 1, 1925,

State of New York } ss.
County of New York }

Before me, a Notary Public, in and for the state and county aforesaid, personally appeared Edgar A. Becker, who, having been duly sworn according to law, deposes and says that he is the treasurer of the Industrial Press, Publishers of MACHINERY, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, The Industrial Press, 140-148 Lafayette St., New York; Editor, Erik Oberg, 140-148 Lafayette St., New York; Managing Editor, None; Business Managers, Alexander Luchars, President, 140-148 Lafayette St., New York, and Robert B. Luchars, Vice-president, 140-148 Lafayette St., New York.

2. That the owners of 1 per cent or more of the total amount of stock are: The Industrial Press: Alexander Luchars; Alexander Luchars, Trustee for Helen L. Ketchum, Elizabeth Y. Urban, and Robert B. Luchars; Matthew J. O'Neill; Louis Pelletier; and Erik Oberg. The address of all the foregoing is 140-148 Lafayette St., New York.

3. That there are no bondholders, mortgagees, or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

EDGAR A. BECKER, Treasurer

Sworn to and subscribed before me this 19th day of September, 1925.

CHARLES P. ABEL,
(SEAL) Notary Public, Kings County No. 153
Kings Register No. 7006
New York County No. 49 New York Register No. 7085
(My commission expires March 30, 1927.)